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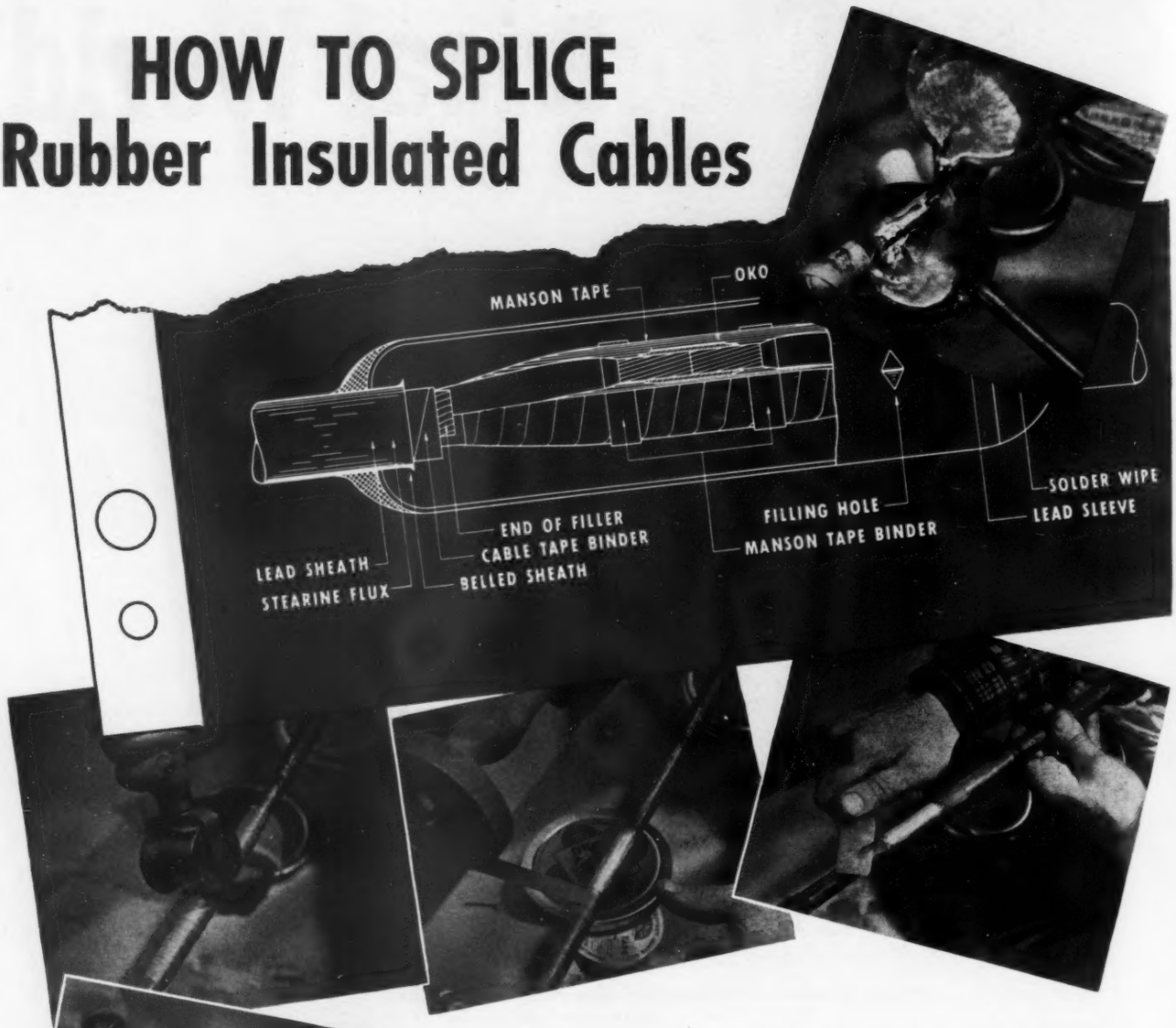

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Original plan for 2,500-pound plant partially modified in execution — Confidence in natural circulation boiler confirmed — Motor-driven boiler feed pumps and high pressure heaters — Resuperheat for low-pressure unit

Twin Branch Extends High Pressure Economies

PHILIP SPORN, Vice-President and Chief Engineer, American Gas & Electric Service Corporation

AIM OF THE Twin Branch 2,500-lb.-pressure project from the very beginning was to make a definite and forward step in the economics of generation of central-station power. It was believed that the time had arrived when the technological limitations to higher pressure and high-temperature steam-electric generation could be advanced and thus contribute both to the capital cost and thermal economies of steam-generated power. This idea was reinforced through extensive discussions and negotiations with the group of forward-looking manufacturers of the principal items of equipment without whose proffered help and cooperation the project could not have been undertaken.

Load Characteristics

But even more it was undertaken because of a strong conviction in the minds of those responsible for the technical-economic welfare of the American Gas & Electric Company systems that no electric utility system can afford to rest long on its technical-economic oars; that to be in a position to sell electric service economically it was necessary for a utility to be in the forefront of advanced sound economic practice and, finally, that in the American Gas & Electric Company systems the cycle of economic steam power generation that started with their first all-turbine (two 500-kw. vertical units) plant in Marion, Ind., in 1905 and which, after a series of then outstanding turbine plants built in 1909–1912, continued with the mine-mouth Windsor plant (1917), Philo (1924), Twin Branch (1925), Deepwater (1930), Logan (1937), Windsor topping (1939), had not come to an end. On the contrary these jobs, which preceded the Twin Branch 2,500-lb. project, served as the ideal and necessary background of experience for the new effort.

Twin Branch, located near South Bend, Ind., is the main generating station of Indiana & Michigan Electric Company, which is part of the Central System of American Gas & Electric Company. The whole Central System serves a combined industrial and residential load, with the industrial load predominating. Supply of power for Indiana & Michigan Electric Company's load is closely coordinated with that of the Central System, but requiring a certain amount of generation locally.

Twin Branch, being the most expensive fuel point on the Central System, is the logical place for the thermally most efficient units on the system. Not only have fuel costs risen since the project was undertaken but the local load, initially estimated to reach a demand of some 165,000 kw. by the time the 2,500-psi. unit went on the line, has actually reached a value of some 225,000 kw. thus far in 1941, with a now expected peak in 1944 of some 290,000 kw. Thus, the developments in the intervening four years have not only justified the bases behind the original aims but have materially strengthened them.

Original Plan

Technically, the project which was rated initially at 67,500 kw., was outstanding for the decision to resort to a single natural circulation boiler, a cross-compound generating unit, of which the high-pressure end would be rated at 22,500 kw. at 3,600 r.p.m. and with a hydrogen-cooled generator, and the low-pressure, a 40,000-kw. unit, at 1,800 r.p.m. with an air-cooled generator, solid switching of high- and low-pressure turbines as a unit stepping up through a single

transformer bank, turbine-driven high-pressure boiler-feed pumps, and low-shell-pressure heaters throughout. The reasons for the above ideas have already been discussed.*

Modifications of Original Plan

Final development of a project having so little precedent resulted in modifications of some of the originally proposed ideas. But it is quite astounding how few these were—particularly of a fundamental nature.

First among such changes was the increase of the unit size from 67,500 kw. to 76,500 kw. As the heat cycle was developed, it was found that not only could greater capacity be developed from the low-pressure machine than originally contemplated, but that the additional steam flow to the high-pressure turbine made possible better economies. The only obstacle to this was heating limitation on the originally contemplated air-cooler alternator for the low-pressure machine. Redesigning this for hydrogen cooling gave a larger machine, a better-balanced unit and an improvement in the economics of the project. Another significant change was from turbine to motor drive for the boiler-feed pumps. Here a thorough analysis indicated that, on account of lower first cost and improved cycle efficiency, motor drive was more logical.

A third change was the use of high-pressure heaters for the 14th stage high-pressure and the cross-over extraction points made necessary by the changed position of the high-pressure boiler-feed pump. The determining factors here were the fear of difficulties with 490 deg. F. water in the pump and the additional pumping load this would have involved.

For the rest, the original projected ideas were adhered to. The boiler was not only built as a natural circulation boiler, but it was done with mounting confidence in the soundness of the design from a circulation viewpoint. The design of the whole plant was kept on the simplest lines. This held true throughout the job. Above everything, there was indulged in no striving for thermal records, *per se*, nor was the job "babied," so to speak. In short, it was handled like any other commercial job in power plant design, with the necessary emphasis on economy and on the economic features.

In the carrying out of the detail design and in the construction of the project the criterion of simplicity, compactness and commercial efficiency previously referred to was rigidly adhered to. No better illustration of that can be given than the transverse cross-section of the plant. Not only was the boiler plant itself built on the compact lines that 2,500-lb. pressure makes possible, but the same ideas were followed in the lay-out and arrangement of heaters, pumps and related equipment and in the arrangement of turbine and condenser. The new section of the plant is a simplified masonry block. Note the relationship between that mass and the rest of the plant and compare that with the fact that the rest of the plant has a rating of 80,000 kw., as against 76,500 kw. for the new plant. This explains in part at least why the design ended up with a cubage per kw. of capacity of less than 25 cu.ft.

Foundations Favorable

Foundation conditions were good sand and gravel, existing to a depth of approximately 30 ft. below the bottom of the deepest footings. A stratum of hard blue and yellow clay about 15 ft. thick underlies the top sand and gravel, and below the clay, sand and fine gravel were found to a depth of 100 ft., the bottom of the borings.

In order to line up the turbine-room operating floor of the new extension with that of the existing plant, the bottom of the condenser-pit foundation slab had to be placed approximately 7 ft. below the ground water level. In the construction of the original plant steel-sheet piling was driven around the entire turbine room area to a depth such that the bottom was embedded several feet in the hard clay layer. This apparently was done in the belief of the original erectors that the existence of artesian water pressure found in the lower soil strata would make it difficult to handle the ground water. This piling had been allowed to remain in place and connections were provided to continue this construction for the building of foundations of future extensions.

A study of borings made, however, prior to the construction of the new extension led to the conclusion that it would be unnecessary to build the work within an inclosure of steel-sheet piling and the new foundations were, therefore, constructed within an open pit, the ground water elevation being lowered by a system of well-points and pumps. Constructing foundations in this manner not only resulted in some dollar saving but in an appreciable reduction in the time required to construct the foundations of the turbine room extension.

Evolutionary Development

The new plant was thus a radical departure from older practice in many of its aspects, but the departure was at no point either revolutionary or of such a nature that it was not possible to harmonize the physical, thermodynamic and electrical features of the plant with what had previously been erected at Twin Branch. That it was possible to do so and that it was possible to bring the plant to a successful operating point with as remarkably little difficulty as has been experienced is due in a measure not only to the earnest and conscientious efforts of all engineers and manufacturers who have participated in the project, but particularly to the fact that the development is definitely an outgrowth of and has incorporated within it all the experience gained in the building and in the operation of such plants as Windsor, Philo, Stanton, Deepwater, Logan and Windsor topping.

No summary of this project would be complete without grateful acknowledgment of the help and cooperation received from those far-sighted manufacturers who participated in the project, of the work done by the operating staff at Twin Branch and of the arduous and skillful work done in working out the many problems in an unprecedented undertaking by all members of the design staff (of which only a small portion are represented by authorship of the following articles).

Finally, it is necessary to pay tribute to George N. Tidd, under whom and with whose help the development was carried through. His inspiring leadership and his youthful enthusiasm for every sound and progressive idea leading to the advancement of the art of power generation, transmission and distribution was an indispensable element in the carrying through of a difficult project.

* See "2,400 Pounds—A New Power Milestone," "Electrical World," October 9, 1937.

Open-Pass, 2,500-Pound Natural Circulation Boiler

Twin Branch steam generator presents novel disposition of superheat and resuperheat surfaces along with unique provision for the expansion of parts

THOMAS B. ALLARDICE, American Gas & Electric Service Corporation

THE Twin Branch 2,500-psi. boiler presented for solution a combination of problems, heretofore solved separately, but in this case called for in a single unit. It has an operating pressure of 2,400 psi. at superheater outlet and a final steam temperature of 940 deg. F. at a flow of 550,000 lb./hour when reheating steam from an entering temperature of 545 deg. F. at a flow of 440,000 lb./hour to a final temperature of 900 deg. F.

Design and operation were to be based on the use of Indiana coal, high in moisture and the ash having a fluid temperature ranging from 1,900 to 2,500 deg. F. This coal normally average 15 percent ash, sulphur 3 percent. It was specified, however, that certain coals might contain moisture up to 18 percent and sulphur to 5 percent.

Little was known about the insulating effect of slag from this ash. It was agreed that before a design would be decided upon further data would be developed.

Pass Details

Accordingly coal-burning tests were conducted on a furnace having the arrangement tentatively contemplated and determinations of the effects of slag insulation on heat-absorbing surfaces were made. From these data a decision was reached resulting in the final design.

The boiler unit consists of a primary furnace, first open pass, second

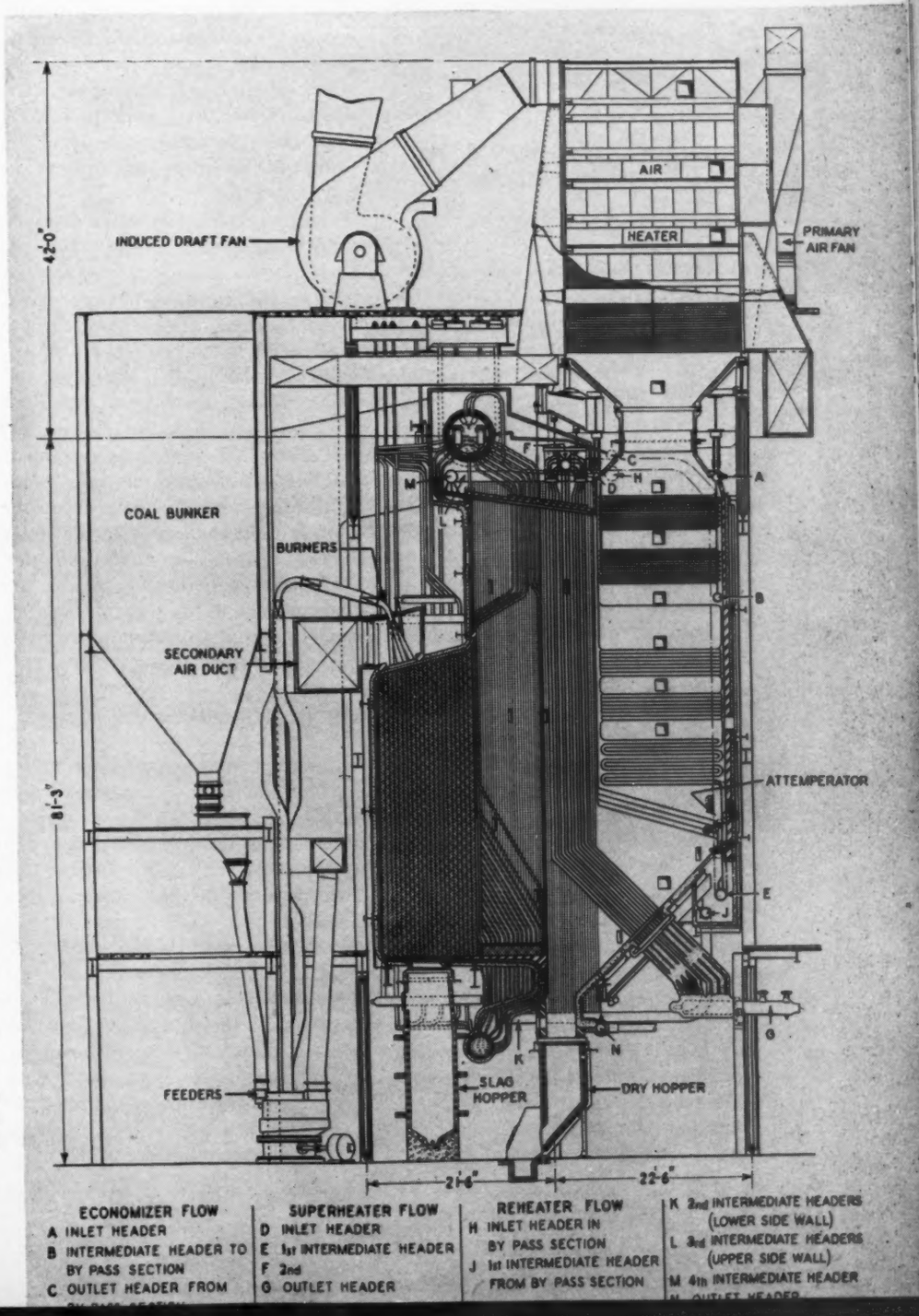

FIG. 1—Single-unit assembly of Twin Branch boiler for steam generation at 2,500 psi., 940 deg. F. with between-unit reheat to 900 deg. F.

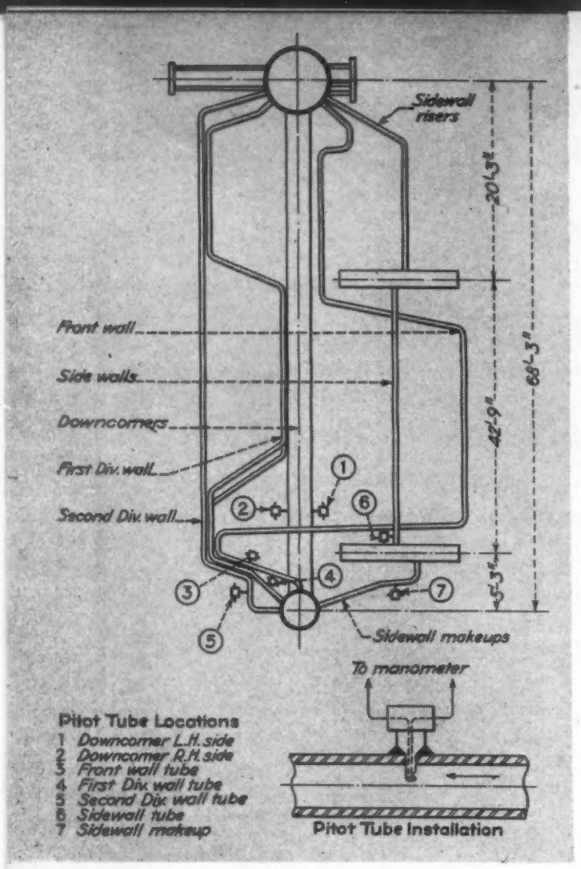

FIG. 2—Pitot tubes used in exploration of flow in steam and water circuits of the boiler

open pass, main and by-pass convection section, economizer and air heater. A section of the boiler is shown in Fig. 1.

It differs from the conventional open-pass design in that the side walls of the first pass and second pass are covered with reheat surface; in the second pass, spaced 3 ft. apart, are platens of second stage (radiant-convection) superheater elements. The division wall between first and second pass is made up of steam generation surface, while the division wall between the second and last pass (convection section) and continuing to form the hopper at the bottom of second pass is reheat surface.

The last pass of the boiler contains initial superheater, reheat and economizer surfaces, the reheater section being placed apart from the superheater and arranged for reheat control by means of baffles and by-pass damper.

For superheat control there is located in the piping between the convection and radiant superheater stages an attemperator (five-spray desuperheater) having a capacity capable of reducing the temperature of the initial superheat approximately 100 deg. The nozzles are designed for flexibility of operation. Temperature control is either by hand or automatic.

As the entire steam generating unit is suspended, all expansion is downward. The drum, 54 in. I.D. and 8.25 in. thick, is suspended by U-bolts. Downcomers, 28 in. I.D., fixed to the ends of the drum and formed into the lower drum, also 28 in. I.D., comprise the main supply circuit. Feedwater enters the economizer inlet header and flows downward through one section and upward through the second section to the boiler drum. The water supply to the evaporating sections of the unit is through the downcomers to the lower drum, the lowermost part of the unit. The floor and front walls of the primary furnace as well as the division walls, forming the first pass, connect directly the lower and upper drum. Side walls are formed of tubes connected to inlet and outlet headers served by circulators and risers connected to upper and lower drums. All risers discharging into upper drum are connected to a collecting chamber, where separation of steam and water is accomplished by cyclone separators.

Saturated steam from the drum enters the first stage or convection section of the primary superheater at the top and flows downward, leaving at the bottom; from there, through the attemperator, entering the second stage header (located at top above second pass); steam then flows downward through the platens and out at the bottom. Due to the expansion of superheater elements being downward, and that all expansion from the high-pressure turbine steam header is taken care of at the boiler, the several superheater platens are connected by means of intermediate headers and expansion tubes to main steam outlet header.

Reheat

Reheat steam enters the reheater through the inlet header located at the top of the reheat convection section, flowing downward through this section, then flowing upward in two parallel paths through the elements located in side walls in the first and second pass, entering the last reheat stage at the header located at the top of the boiler, flowing across the section forming the roof of the first and second pass, flowing downward through the division wall, the screen across the convection section, the hopper floor tubes, and leaving through the header located at the bottom.

Eight burners of the vertical intertube type are used for vertical firing. Oil burners arranged for burning No. 3 fuel oil, having a capacity of generating 50,000 lb. of steam per hour, are used for coal ignition. Lighting of oil burners is by hand oil torch.

Coal Pulverization

Four totally inclosed dust-tight coal scales of the batch automatic dump type are provided to weigh coal to each mill. Coal feeder piping between scales and feeders is equipped with sight glasses as well as "no flow" coal alarms.

Coal is pulverized by four type E size 53 mills, each driven by one 100-hp., 600-r.p.m. constant-speed, high-torque motor. The capacity specifications require that when one mill is out of service the remaining mills shall have a capacity of 80 percent of total boiler output, with no reduction in coal fineness. Coal feeders, one per mill, are of the table type and are driven by one 2/1-hp., 1,800-900-r.p.m. multi-speed motor. The rate of feed is controlled by the automatic coal level control, which maintains approximate constant coal level in the grinding zones; it is actuated by the differential pressure across the grinding elements.

Combustion Air

Primary air to the four mills is supplied by one primary air fan having a capacity of 38,600 c.f.m. at 25-in. static pressure, discharging into a divided section of the air preheater designed for preheating the primary air from 125 deg. to 390 deg. F. when operating at capacity. The use of one fan for primary air supply is not usual; however, space limitations and an arrangement of air heater permitting flexibility of temperature control made this arrangement desirable. Temperature control of this section of the air heater is by means of dampers controlled from boiler panel.

Secondary air is provided by one forced-draft fan having a capacity of 153,000 c.f.m. at 11.6-in. static pressure driven by one 400-hp., 1,160-r.p.m constant-speed motor. This fan is equipped with inlet vane control; secondary air temperature at discharge of the air preheater ranges between 520 deg. and 570 deg. F.

Induced draft is provided by two

fans, each having a capacity of 170,000 c.f.m. at 365 deg. F., 17.8-in. static pressure at 870 r.p.m., requiring 750-hp. constant-speed motors. Vanes are installed in the inlets of the fans for volume control. A special arrangement of inlet boxes and vanes provides for dust elimination.

A horizontal tubular air preheater is located immediately above the economizer. A total of 133,500 sq.ft. of surface has been provided, made up of 1½ O.D. 14-gauge tubes 20 ft. long, arranged in two sections, one primary (for mill air supply) and one main section. Air flow is through the tubes, two-pass, counter-flow to the gas, which flows vertically.

As the boiler is designed for continuous ash removal from the primary furnace, molten slag flows into a primary ash storage pit, continuously agitated by water jets, so that large formations of slag are not encountered. The secondary ash pit located at the bottom of the second pass is designed for either wet or dry ash storage. Water is used as a seal in the expansion joint between the boiler and ash pits.

Final ash disposal is accomplished hydraulically to a receiving pit located outside of the building. Dust from collectors is handled in a like manner.

Soot blowers of the conventional type are installed in the convection pass and also in the air heater. In the second pass telescopic units are now in trial use.

Circulation

There is little doubt that the element of the Twin Branch project that aroused the greatest comment and anticipatory interest was the decision to resort to a natural circulation boiler. As has already been pointed out, this decision was based on sound technical reason, and no difficulty due to circulation was looked for by the designers, nor by the project engineers. Incidentally actual experience has borne this out. But, nevertheless, it was realized that the selection of an operating pressure of 2,500 lb. on the boiler unit with natural circulation required that all the circuits in the steam-generating areas of the boiler should be as direct as possible.

The flow of circulating water from the system drum into the downcomers was studied carefully, both from the standpoint of determining safe minimum operating drum level and the elimination of steam entrainment in the water going to the downcomers, in order to avoid diminution of the available circulation head. Tests were conducted on a full-sized, half-length section of the steam drum, including a section of the downcomers. The effectiveness of the final design is evidenced by operating tests, which determine 96 percent solid water at capacity operation.

Flow Studies

All areas of the boiler circulation systems were calculated on the basis of heat-absorbing tests mentioned previously. Considering the various areas of the unit separately, the accompanying table gives the calculated as well as the actual flow as determined in operation in the separate sections. From this table it can be seen that actual flows are not only well in excess of that calculated but in excess undoubtedly of what is obtained in many natural circulation boilers operating at pressure ranges well below the operating pressure of this boiler.

Measurements of flow were determined by pitot tubes initially installed in all generating circuits of the boiler. A diagram illustrating the circuits in which the circulation measurements were made is shown in Fig. 2.

Starting Up Procedure

Experience on large boiler units elsewhere on the American Gas & Electric Company system has indicated that the use of Calgonite for the removal of foreign matter deposited in the unit during the course of erection when used in the proper concentration was highly effective. The proportion of chemicals used per thousand pounds of water was approximately: Calgonite regular 6.7 lb. and caustic soda 1.3 lb. Because of the quantities involved the chemicals were introduced into the boiler in solution.

Prior to boiling out, the boiler was completely filled to the top of the drum with water treated with sodium sulphite and heated by means of the hydrokineter to approximately 200 deg. F. Water level was then dropped and chemicals added. Over a period of eighteen hours and after pressure had reached 75 psi. the boiler was blown down intermittently, solids being reduced from 10,000 to 5,000 ppm. Over a period of 20 hours pressure was increased to 275 psi. and maintained for five hours; during this time steam was vented from the unit. During this period the blowdown was operated continuously, reducing the solids to 500 ppm.

Blowing Superheater

At a pressure of 275 lb. the superheater and high-pressure steam lines were blown to atmosphere. After

Table of Total Flows, Boiler Areas
(Pounds per Hour)

Circuit	Calculated Flow Steam Output 550,000 Lb.	Measured Flow Steam Output 530,000 Lb.
Downcomers	3,600,000	5,300,000
Front wall	960,000	1,240,000
First division wall	1,020,000	1,610,000
Second division wall	920,000	1,640,000
Furnace sidewalls.	700,000	840,000

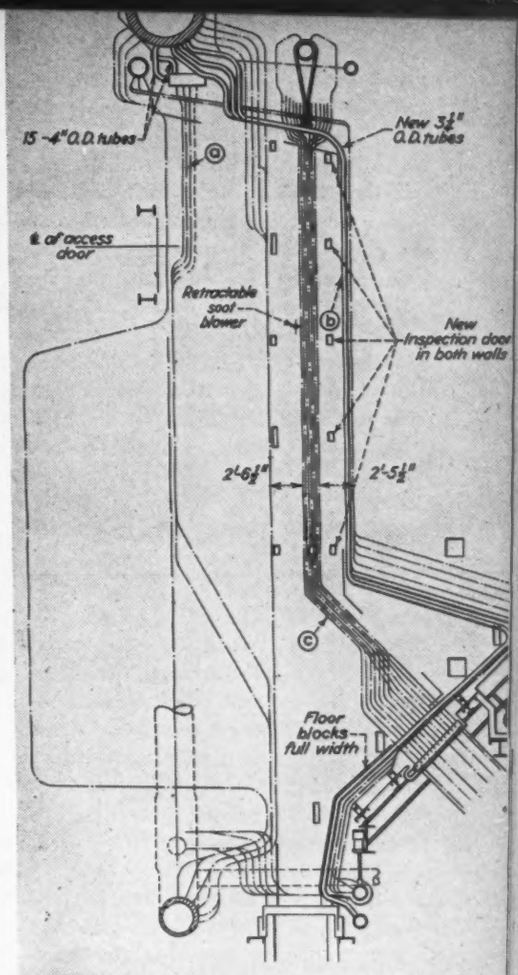

FIG. 3—Experience in operation indicates some fu changes in configuration of parts—(a) Screen tube top of first pass to be rearranged. (b) Superhe platens to be regrouped for less surface exposure greater accessibility. (c) New waterwall surface t applied in front of division wall and dry-ash hopp

draining the boiler, an inspection revealed that all surfaces inside the unit visible for inspection were free of oil and other matter, requiring no further boiling out. The boiler was then closed for routine starting up.

The starting up procedure is fairly simple. Limiting requirements are that temperature differences in the metal of the drum shall be controlled carefully to 50 deg. F. Thermocouples attached to top, bottom and sides of the drum and recorded on charts at the operator's control panel serve as a guide on the rate of temperature change.

The initial heating of water in the boiler to approximately 200 deg. F. is by steam from the old section of the plant, introduced by means of a hydrokineter located in the lower drum. During this period the steam drum is maintained full of water to heat all portions of the drum at the same rate. When the temperature reaches approximately 200 deg. F. the water is lowered in the drum to normal operating level.

The oil burners then are placed in service; steam from the old section of the plant is circulated through the reheater sections to protect from overheating these portions of the boiler while the pressure is gradually raised to approximately 400 lb. gauge.

Raising the Pressure

Between 400 and 600 lb. gauge flow to the turbines is established, oil firing only being used. The pressure is gradually raised until the turbine is on the line and in service, when mills are put in service and normal boiler operation is carried on.

Removing the unit from service on a scheduled shut-down is accomplished with little difficulty, after pressure has been reduced by continued turbine operation, with reduced firing to a determined pressure between 600 and 700 lb. per sq.in. and load on the boiler reduced to approximately 100,000 lb. per hour. The turbine is taken off the line and all firing in the boiler is shut off. Drum is filled with water to the top of the boiler and then allowed to cool down with the I.D. fan running intermittently. Temperature differences are controlled at the prescribed rate of 50 deg. F. per hour.

The necessary drain, vent and blowdown procedures common to all boilers are of course carried on.

Boiler water is sampled from the blowdown connection located on the lower drum.

For the purpose of determining steam conductivity continuous steam samples are taken by means of ASME nozzles at the following points:

1. Saturated steam from tubes between the drum and superheater inlet header.
2. At discharge of primary superheater.
3. At discharge of secondary superheater.

Feedwater is sampled continuously from economizer discharge.

Sampling

Conductiveness of samples are recorded by an L. & N. strip chart recorder, having individual manual temperature compensators.

In order to determine hydrogen evolved in either the boiler, primary superheater or the combined primary and secondary superheaters, provision has been made to deliver the saturated sample and any of the other three samples to a Cambridge hydrogen recorder.

Design Modifications

The difficulties experienced during operation, related in more detail elsewhere, consisted of excessive slag accumulation in the first and second passes of the boilers as well as high superheat and reheat temperatures. A slight amount of carryover was also experienced. All of these difficulties are due primarily to an unbalance in the heat-absorbing areas of the unit.

During the first two weeks of operation tube temperatures, steam temperatures, heat inputs and other operating conditions were carefully checked; it was decided that a temporary remedy consisting of a thin coat of refractory applied to the reheat side walls and on a portion of the reheat division wall would partially correct the condition of high reheat, allowing for further checking at higher ratings. Resultant data indicated that an addition of water surface and a reduction of superheater and reheater surfaces were required to correct the difficulties of temperature and slag. Steel plates were then applied to the bottom of the reheat hopper to protect them against damage due to falling of large slag accumulations. This armor served two purposes—the first being protection to the reheater elements and, second, the covering of additional reheat surface. A further attempt at reducing reheat temperature was the blocking off of a portion of the reheat convection surface, which gave further relief, permitting higher outputs and continuous operation of the unit.

Surface Rearrangement

Rearrangement of surfaces has been agreed upon between the project engineers and designers and it is believed this will enable the unit to operate as originally specified. The changes consist of:

1. Rearrangement of screen tubes at the top of the first pass. This change, it is believed, will eliminate the fouling of these tubes at low ratings.
2. The installation of additional water surface immediately in front of what is now the reheat division wall and hopper. This surface will completely cover this section of the reheater. It is formed of water tubes rising from a header located below the reheat outlet header and entering the drum through the connections now utilized by the screen tubes that form a part of the division wall between the primary furnace and the first pass. The surface of tubes forming the hopper will be covered by cast-iron blocks for protection in the event of slag fall. This change, it is believed, will reduce the reheat to the desired level.
3. Superheater platens will be regrouped so as to reduce the surface exposed to the hot gases and at the same time afford accessibility in this pass not now possible.
4. It is planned also to install seven additional access doors on each side of the second pass for better inspection and cleaning.

There are no changes contemplated in the other areas or equipment now in service. It is confidently believed that with the corrections outlined superheat and reheat control will be had within the ranges specified and that the attemperator, by-pass dampers, etc., will give the flexibility of operation required up to full rating. It is worthy of note that while this is being prepared the boiler is supplying successfully and continuously a load of 60,000 kw., with peaks of 75,000 kw. for periods of short duration.

Standard Turbine Designs Easily Adapted to 2,300 Psi.

Twin Branch pressure necessitates resuperheating of steam to the low-pressure unit to promote cycle and turbine efficiencies

G. B. WARREN and THEODORE BAUMEISTER†*

OUTSTANDING FACTS about the Twin Branch turbines designed for 2,300 lb. per square inch and 950 deg. F. throttle conditions and 900 deg. F. resuperheat temperature are (1) the relative ease with which standard types of design were adapted to these severe operating conditions and (2) the relatively few difficulties encountered in the manufacture and placement in service of these units at these conditions.

A resuperheating cycle lends itself well to the design of a cross-compound turbine-generator set with the high-pressure unit at 3,600 r.p.m. and the low-pressure unit at 1,800 r.p.m., since inherently in resuperheating cycles of this type the high-pressure turbine has from one-quarter to one-third the capacity of the set. Building the high-pressure unit for the higher speed permits smaller wheel diameters and thus reduces rotation losses. It results in long radial dimensions for nozzles and buckets relative to wheel diameter, which in turn is conducive to high efficiency. It permits packings of smaller diameters and consequent lower losses. It permits building the turbine shells to smaller dimensions, which greatly reduce the bolting problems and the problems associated with distortions from pressures and temperatures.

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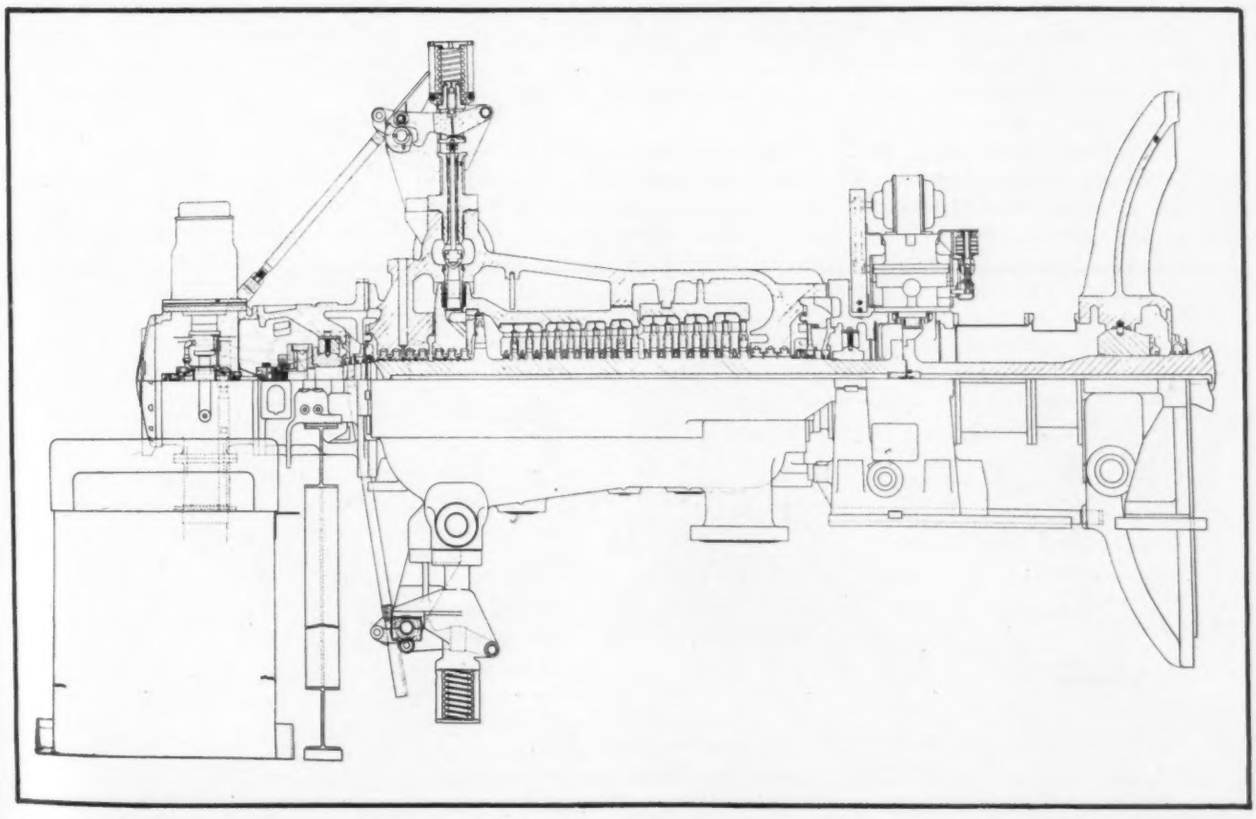


FIG. 1—High-pressure, 3,600-r.p.m., double-shell unit of 76,500-kw. cross-compound turbine at Twin Branch. Eleventh stage extraction taken between two parts of inner shell; 14th stage extraction through holes into chamber between inner and outer shells

Lower speed for the low-pressure unit, on the other hand, does not unduly handicap the earlier stages of this unit as far as bucket lengths, rotation losses and packing diameters are concerned because of the relatively low pressure (400 psi.) at which the steam enters. At the same time the larger diameters, permitted by the lower speeds, make possible a simple, single-flow, single-casing turbine with sufficient last-stage bucket area to keep the leaving loss low.

High-Pressure Turbine

The high-pressure unit is of the proved double-shell construction (Fig. 1), in which an inner shell with its own bolting flange surrounds the high-pressure section of the turbine rotor. This inner shell is supported so as to remain concentric with the main outer shell.

Maximum conditions in the first-stage wheel casing of the inner shell are 1,900 psi. and 910 deg. F. in the space between the inner and outer shells at full load 955 psi. and 750 to 840 deg. F. This condition, in conjunction with the double shell construction, divides the bolting loads between two rows of alloy bolts. The outer casing is not subjected to pressures and temperatures beyond prior experience. Further, a simple internal piping system, with no valves or other controls, permits about 75 deg. F. steam cooling of the inner-shell bolts at high loads and steam heating of these bolts upon starting, thus reducing creep at higher loads and overstretching at starting.

Eighteen stages of comparatively small diameter have been used in order to make certain that the shortest buckets will be long enough to maintain good efficiency. The first stage buckets are 0.75 in. in length and steam is admitted at full load around 287 deg. of arc. The buckets in the second row are 1.06 in. in length and steam is admitted around the entire circumference at all loads.

Steam chests for the controlling valves are placed one above and one below the center line of the turbine, there being six controlling valves, with three in each steam chest. Valve stems run through hardened steel bushings without soft packing. Two intermediate leak-offs are provided to handle small amounts of steam leaking along the valve stems. Each valve chest is fed by two $3\frac{9}{16}$-in. inside diameter steam pipes, making four in all coming from the stop valve. The stop valve is anchored in front of the turbine. These four $3\frac{9}{16}$-in. steam leads give sufficient structural flexibility to allow the stop valve to be anchored and yet avoid imposing any undue forces on the turbine proper.

The turbine shells are anchored at the No. 2 bearing pedestal and are free to expand forward by virtue of being supported on a flexible steel "A" frame resting on the foundation which is back of the oil tank.

Low-Pressure Turbine

The low-pressure turbine is a modification of typical 1,800-r.p.m. single-flow General Electric turbines. In fact, in 1937, when the Twin Branch extension was planned and the turbine purchased, it was found that a large number of parts of such a turbine had been manufactured and were available from stock. By building a new alloy-steel high-pressure casing to accommodate the 900 deg. F. steam conditions and by making the diaphragms and wheels of the higher pressure part of this machine of proper materials and proper proportions the stock parts could be adapted to the requirements of the low-pressure turbine of this set.

Since the low-pressure element operates on resuperheated exhaust from the high-pressure unit, and since the pressure varies in proportion to the load on the total set, no controlling valves, as such, were required. The low-pressure turbine accordingly operates with full peripheral admission to the first stage at all times.

High-Pressure Advantages

Two factors are conducive to an advantageously small last stage of the low-pressure turbine. One is the extremely large heat drop (720 B.t.u. per pound) arising from the use of 2,300 psi. and 900 deg. F. with resuperheating, and the other is the large (34 per cent) extraction for feed heating (compared with 20-25 per cent for many lower pressure jobs). This increased extraction does not reach the condenser and an additional gain is, therefore, in the smaller size of steam condenser.

The efficiency of the low-pressure turbine is high because of utilizing resuperheated steam and maintaining

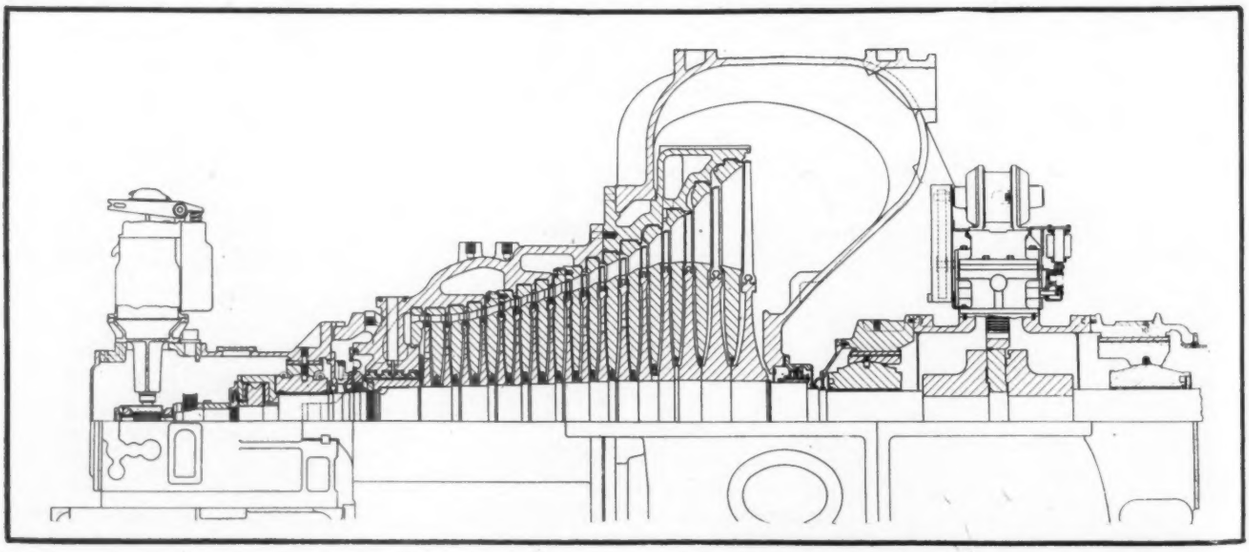


FIG. 2—Low-pressure, 1,800-r.p.m., single-flow condensing unit of Twin Branch cross-compound turbo-generator. Essentially stock design was modified by provision of alloy-steel casing for the inlet end because of 900 deg. F., resuperheat temperature

superheat conditions through the first two-thirds of the unit, thus holding the moisture content in the exhaust to a maximum of only 6.5 per cent.

Control Equipment

Normally the entire control of the cross-compound set is in the speed-sensitive governor on the high-pressure element, which controls the position of the high-pressure turbine inlet-valve in the usual manner and which is biased by the usual type of synchronizing motor. The high-pressure valves are arranged with a hand position load limit which can be used to run the complete unit on blocked governor and blocked valve setting, if desired, for starting.

On resuperheated-steam turbines it is necessary to install an intercepting valve in the steam lead from the resuperheater to the low-pressure turbine to prevent the steam contained in the resuperheater and connected piping from overspeeding the low-pressure element on loss of load from the set.

In the case of the Twin Branch machine the intercepting valve serves a dual purpose, inasmuch as one of the specified requirements was that the low-pressure turbine should operate independently of the high-pressure unit on 600 psi., 750 deg. F. steam from spare boiler capacity available in the station. By adding a 600-psi. stop-valve ahead of the intercepting valve it is possible to change the setting of the governor, which is normally used as a pre-emergency governor, and utilize this intercepting valve as a controlling valve for the low-pressure unit when independently operated.

Drop in Load

In view of the small storage capacity of the boiler the governing system is so arranged as to avoid an abnormal drop in the boiler drum pressure in the event of either a sudden demand for more load or of a reduction in the firing rate of the boiler. This was desired in order to limit the resultant stresses on the inner surface of the comparatively thick-walled boiler drum. Either condition requires some closing of the turbine valves in the event the initial pressure decreases, and at such a rate as to maintain the pressure within a predetermined range, that is somewhat under the normal operating range.

The manufacturer undertook to build such an equipment, but found it first necessary to develop a steel bellows capable of withstanding the high pressures involved and possessing the requisite sensitivity and fatigue life for the deflections involved. A suitable bellows has been developed and controlling mechanism designed and built and it will be installed on the turbine in the near future.

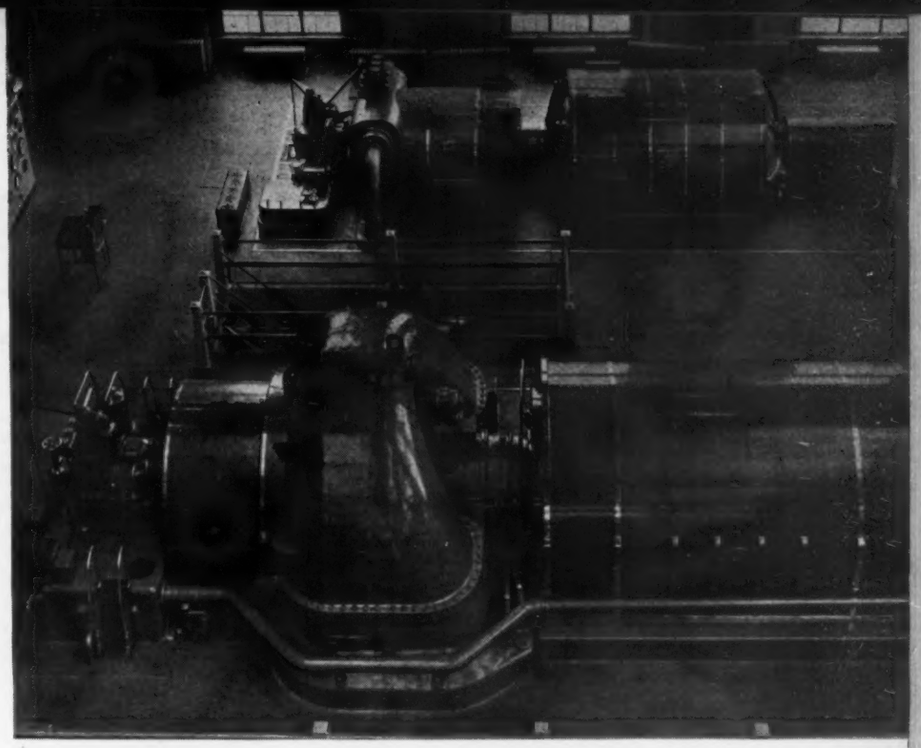


FIG. 3—The 76,500-kw., 2,300-psi., 900-deg. F. cross-compound turbo-generator at Twin Branch

Operation

Anticipated difficulties had to do with the realization that in the event of loss of load the high-pressure rotor contracted axially much more rapidly than the shell. In previous turbines of this general type, but built for half the pressure, the rotors had been sufficiently larger and the shells sufficiently lighter, so that their rates of heating were more nearly comparable and hence did not seriously change the axial clearances in the machine. Although these wheel clearances are not particularly small, it was felt that an unreasonably rapid rate of reduction in load might cause some rubbing and unnecessary increase of clearances with a slight loss in efficiency. Accordingly an operating technique of closing the intercepting valve to the low-pressure turbine was adopted by which the cross-over pressure would be temporarily raised to prevent the rapid cooling off of the high-pressure rotor. This is being taken care of with hand adjustments for the time being, and modifications are being made to the governing equipment whereby it will be done automatically in the future.

There were the annoying difficulties generally encountered with blade deposits and feedwater treatment when a new station at higher pressures is passing through its early operating history. Only one additional operating difficulty has been encountered which, it might be said, could be associated with the higher pressure. On account of the extremely small size of the high-pressure turbine rotor, resulting from the low volume flow, its low weight, and the fact that the bearings had to be proportioned so that the shaft could carry the required torque, the loadings on these bearings became very low, leading to the now well-recognized tendency toward unsteady running of journals in such lightly loaded bearings, sometimes called "oil whip." This was completely corrected by the installation of a stabilized type of bearing.

Generator Cooling

The generators of both the high-pressure and low-pressure turbines are hydrogen cooled. This tends to a very great extent to reduce the generator losses. Both generator cooling systems are connected to a common treating equipment for extracting hydrogen and air from the sealing oil.

Heater and Pump Problems No Obstacle to 2,500 Psi.

Economic basis for heat balance pattern — Design was influenced by existing 600-psi. plant — High-pressure heater design founded on metallurgical research — Condenser is the first of new type

E. H. KRIEG, American Gas & Electric Service Corporation

THERMAL ECONOMY was patiently sought in the Twin Branch design, but only within proper limits of over-all financial efficiency. These considerations are closely related to the development of the heat flow diagram and the heat balance. Considerations of financial efficiency explain the major differences between the actual flow diagram and that originally forecast in an ELECTRICAL WORLD article, October 9, 1937, "2,400 Lb.—A New Power Milestone," by Philip Sporn. Some eighty sets of calculations were made to evolve the final heat balance.

After the condenser, the condensate normally is pumped through the generator hydrogen coolers. Generally, this would be open to question, but the reasons were:

1. When air or hydrogen coolers supplied only with condensate are installed an auxiliary bank of service water air coolers requires an additional cooler investment cost of about 50 percent, but the coolers at Twin Branch use condensate for nine months of the year and are then switched in July to service water for the three summer months.

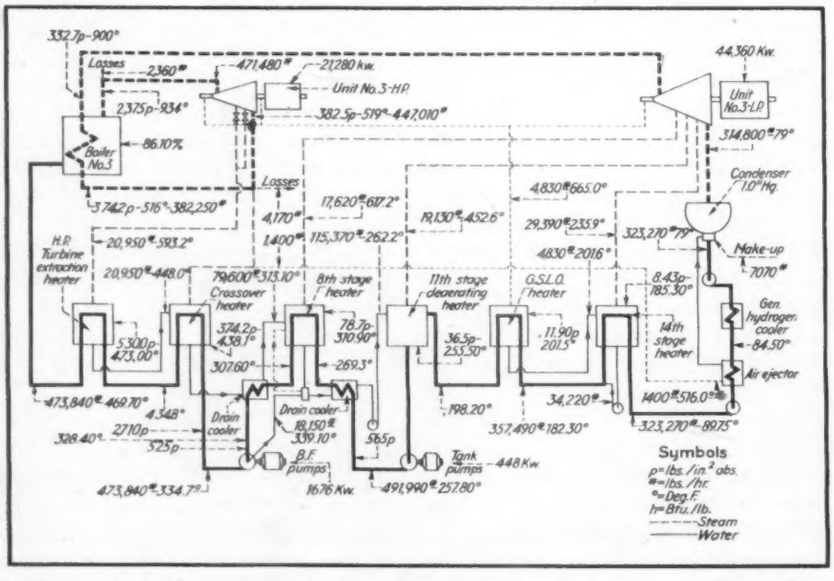
The average yearly river temperature being 56 deg. F., a substantial heat saving is thus effected, the only investment cost being in valves and piping, with none for coolers.

2. In system plants having service water coolers maintenance is necessitated for cleaning mud, leaves and trash and dezincification. This is largely avoided by using only condensate for nine months. No coolers could economically be installed to use condensate without supplementary cooling with service water.

3. Because the lowest extraction belt that could be obtained on the turbine was 11 psi. abs., the heat gained from the hydrogen coolers is worth more than if a lower bleed pressure of, say, 6 psi. abs. could have been had.

For much the same reasons condensate only is used in the steam-jet air pump inter- and after-condensers, with not even a service water starting section. During starting condensate is recirculated and by-passed back to the condenser and cooled.

The heat balance shows an obviously large temperature increase in the 14th stage heater, but this was not from choice. The low-pressure turbine was an available machine already cast with the bleed belts an integral part of the shell, which precluded extracting at a pressure of perhaps 6 psi. abs. rather than that given.



HEAT BALANCE for 2,500-psi. cycle at Twin Branch resulted from careful balancing of equipment costs against thermal gains

Leak-off Cooler

To obtain a maximum of 14th stage bleed, the installation of a gland steam leak-off condenser was easily justified. In many other respects, also, it is better to use a gland steam leak-off condenser rather than to return gland steam to the turbine or an extraction heater. For example, the gland steam is so hot that special construction (an inclosed desuperheat zone) is justified to protect parts from excessive heat, particularly during starting, when there may be insufficient con-

densate flow to keep an ordinary low-pressure bleed-heater cool enough to prevent damage.

The deaerator is in the usual position in the cycle; the steam pressure is above atmospheric down to minimum load on the turbine and yet not so high at maximum load as to cause unduly expensive construction.

Placing the tank pump next in the cycle was a natural result from satisfactory operation at Logan and Windsor, where no trouble with flashing between the deaerator and tank pump occurred, chiefly because the deaerator was placed high above the pumps and the piping carefully designed to avoid horizontal runs and friction losses.

Drain Coolers

Choice of location for the eighth stage drain cooler, the eighth stage heater and the cross-over heater drain cooler involved several difficult economic factors.

1. What temperature of water the boiler feed pump could handle without causing high maintenance or poor availability.
2. Cost of heaters of various pressures.
3. Cost of feed-pump and tank-pump combinations with various pumping loads.
4. Whether it would be practicable to have variable speed tank-pumps with heaters between the tank and feed pumps.
5. Cost of power for pumping with various feedwater temperatures.

The heat balance shows no evaporators in the cycle because these existing evaporators have ample capacity so long as 600 psi. units 1 and 2 are operated at sufficiently high load.

Many studies in literature had used constant turbine efficiencies for various throttle steam temperatures without realizing that appreciable gains in turbine efficiency were possible in going to high temperatures of 900 deg. F. with comparatively low-pressure turbines of less than 400 lb. pressure.

The Twin Branch heat balance studies have been valuable in focussing attention on the advantage of high temperature in improving the efficiency of lower stages of condensing turbines.

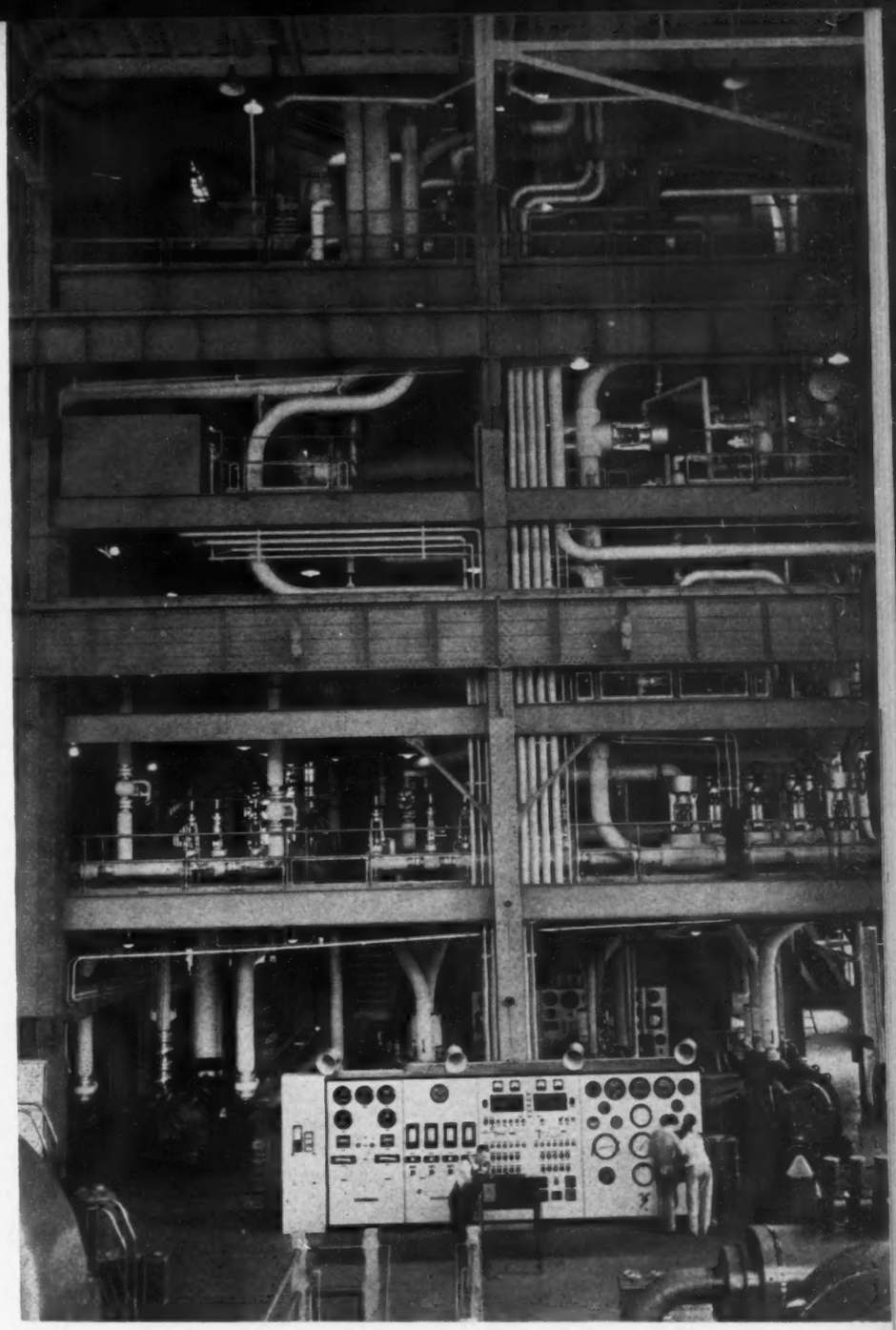
The three Ingersoll-Rand high-pressure boiler feed pumps are 5-in., eight-stage, direct connected to 2,500-hp., 3,600-r.p.m. motors. Normally one pump carries the full load of the high-pressure section of the plant. Each pump is rated at 550,000-lb. per hour, 1,230-g.p.m., 340-deg. F., 2,800-psi. discharge pressure, 700-psi. suction pressure.

Forged-steel barrel-type casings were used and inner casing assembly can be removed as a unit. It was hydrostatically tested in the manufacturer's plant to check soundness of castings and gasketed joints before assembly in the outer barrel.

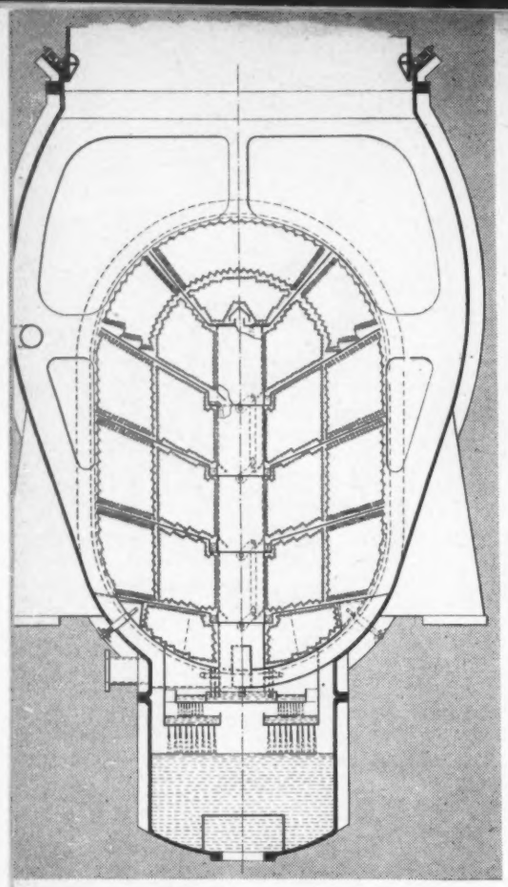
To compensate for sudden temperature changes a patented expansion joint was used between the inner and outer casing to seal this space from discharge pressure.

Further, the differential pressure across any gasketed joint in the inner case assembly is reduced to one-half the generated pressure by a passage leading from the fourth stage to the space between the inner and the outer casings.

To break down the high pressure ahead of the packing, a double-stepped type labyrinth is used, and the leakage from these labyrinths is returned through a common header



BOILER auxiliaries and interconnecting piping occupy open galleries between turbine hall and the 2,500-psi. boiler



NDENSED STEAM and non-condensable gases accumulate in center space of inverted-U condenser. To luce the tendency toward saturating condensate by posing it to the air-steam mixture in the core, the mting collecting plates feed the condensate into ughs from which downcomer pipes permit flow to the per collecting tray in the hotwell

to the eighth stage heater at approximately 150 psi. pressure. As a further aid to good operation, a patented deep water-cooled stuffing box is used, employing directed circulation to cool the stuffing box subjected to the hot leakage water from the labyrinth chamber.

Pumps are hydraulically balanced and a Kingsbury thrust bearing steadies the rotor during sudden load changes.

Couplings and Drives

Couplings connecting the feed pumps to their driving motors are Waldron all-metal, continuously lubricated type of "spacer" design.

Pumps are protected from excessive temperature rise at low flows by an automatic by-pass valve controlled from a flow meter in each pump suction line and have forged-steel barrels or outer casings, discharge heads and nozzles. The high-pressure discharge piping is welded directly to the discharge nozzles of the pumps.

Pumps are mounted on baseplates with temperature-compensating supports designed to take care of longitudinal and circumferential expansion and yet retain constant elevation of the pump shaft.

Because more wear and maintenance were expected with the pumps than with the motors, only two motors were purchased. Complete arrangements were made to facilitate moving the motors where needed, such as overhead traveling hoists, sets of shims and oil piping. At the pump manufacturer's shop each motor was fitted to each of the three pumps. An electrical throw-over switch was installed at the motors so that only two sets of cable and motor controls were required.

Tank Pumps

Boiler-feed pumps are supplied with water by two 6-in., seven-stage, Ingersoll-Rand tank pumps driven by 800-hp., adjustable-speed, 1,800-r.p.m. motors. Each tank pump is designed for 600,000 lb. per hour, 1,275 g.p.m., 262 deg. F., 700-lb. total head and 50-ft. net positive suction head. Normally one tank pump is in service with one feed pump. The variable speed of the tank pump is utilized to meet variations in station load, thus maintaining nearly constant differential pressure of about 200 lb. across the feedwater regulating valve, as described in the article on controls and instrumentation. These tank pumps were specified to have a discharge pressure essentially the same as the older boiler-feed pumps serving the 600-lb. section of the plant and are so connected that the spare capacity among them can be utilized for backing up the new tank pumps. This gives the benefit of a second spare pump without the expense.

Besides the saving of power, made more valuable by the high fuel cost, the improvement in feedwater control alone provided ample justification for adoption of adjustable speed.

Bleed Heaters

The principal data on the bleed heaters at Twin Branch are given in the tabulation on page 94.

All intermediate-pressure and low-pressure heaters were furnished by the Griscom-Russell Company and are of the straight-tube, floating-head, removable bundle type. The water-box closures of the intermediate-pressure heaters are of the double-bolted type, in which one set of bolts supports the hydraulic load while another set applies pressure to the gasket flange to maintain gasket tightness without carrying any hydraulic load.

High-Pressure Heaters

The high-pressure heaters (cross-over and high-pressure extraction) were manufactured by the Foster Wheeler Corporation and employ the Lockhead type of water-box closure. Both heaters are designed for a maximum feedwater pressure of 3,200 psi. and a maximum feedwater temperature to the boiler of 492 deg. F. Monel metal is used for the tubes ($\frac{3}{4}$ in. O.D., No. 13, BWG) because it has the most suitable characteristics from the standpoint of corrosion-resistance and the necessary strength to secure a tube of moderate wall thickness, monel having the same allowable stress as steel. It was found that the same surface in each heater would give about twice the terminal temperature difference on the cross-over heater as on the high-pressure extraction heater.

The tube bundles of both these heaters are alike, except that the high-pressure extraction heater has a de-superheat zone and the cross-over heater none. The shell of the cross-over heater is designed for a maximum pressure of 480 psi. and 600 deg. F., of the high-pressure extraction heater for a maximum pressure of 700 psi. and 650 deg. F. Although these heaters contain only 1,800 sq.ft. of surface, they are 35 ft. 6 in. over-all length; the high-pressure heater weighs approximately 25 tons empty and 30 tons flooded for test.

Heater Leakage

The stationary head has its own support, while three sets of trucks riding on rails support the shell of each heater, which is installed horizontally. It is a relatively easy matter to roll the comparatively light shell off the heavy bundle and heads on the tracks.

The 3,000-lb. feedwater piping is welded to the nozzles on the heads.

A feature of these heaters is the method suggested by the project engineers to detect leakage across the gasket. A telltale was devised to indicate such leakage by drilling a small hole through the floating-tube sheet out-

side the tube bundle. This hole terminates in an annular space under the gasket flange of the sealing diaphragm. If leakage through the floating-head-sealing gasket develops, the pressure in the annular space will rise above shell pressure due to the restricted passage through which the leakage must flow to get into the shell proper. A small monel metal tube is run from the other end of this hole in the tube sheet the length of the bundle and out through the stationary head shell flange, where a pressure gauge and relief valve are installed. A pressure above shell pressure indicates leakage of the floating-head gasket.

First Monel Tubes

Because these heaters were among the first to use monel metal tubes, the research and development department of the International Nickel Company did much work in collaboration with Foster Wheeler Corporation to determine the proper heat treatment and drawing technique.

The monel metal tubes were annealed at 1,000 deg. F. after the final drawing operation, and each tube was hydrostatically tested to twice the design pressure; *i.e.*, 6,400 psi.

It was felt that the size and weight of the heads and tube sheets required unusual care in bringing these heaters up to operating temperature and that it was not desirable to subject them to 3,200 psi. until they were as near as possible to operating temperature. They are warmed up with by-passed steam, under hand control, for a period of two or three hours before feedwater flow is established and the bleed steam pressure reached.

No difficulty attributable to design or pressure has been experienced with these heaters. Hot drains are flashed in separate flash tanks or combined flash and drain tanks so that only flashed steam goes to the steam space of the heater, the drips going to its hotwell.

This is done to:

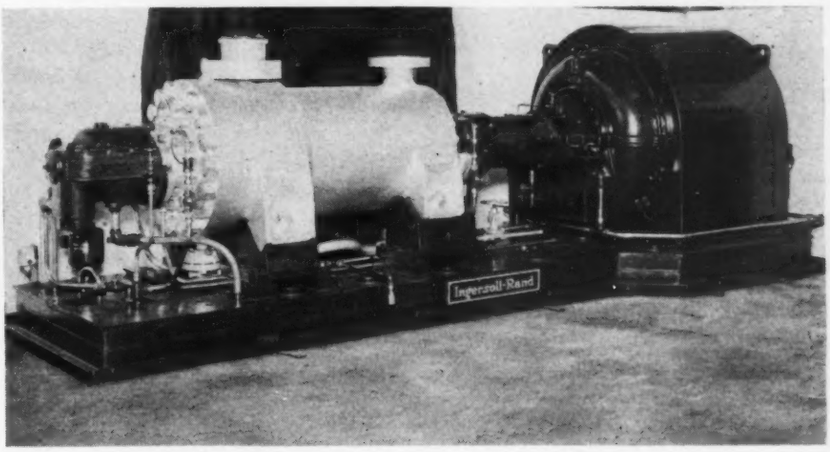
1. Save heater maintenance caused by erosive action of the flashing mixture on shells, tube sheets and tubes.
2. Get better control of the drainage system.
3. Get proper level control to preclude passing steam directly to the next lower heater in case the valve sticks open or lags. It also prevents flooding the heater by passing too little water. The latter effect is dangerous from the standpoint of protection of the turbine.
4. To avoid flow disturbance in the heater shell.

Protection of Heaters

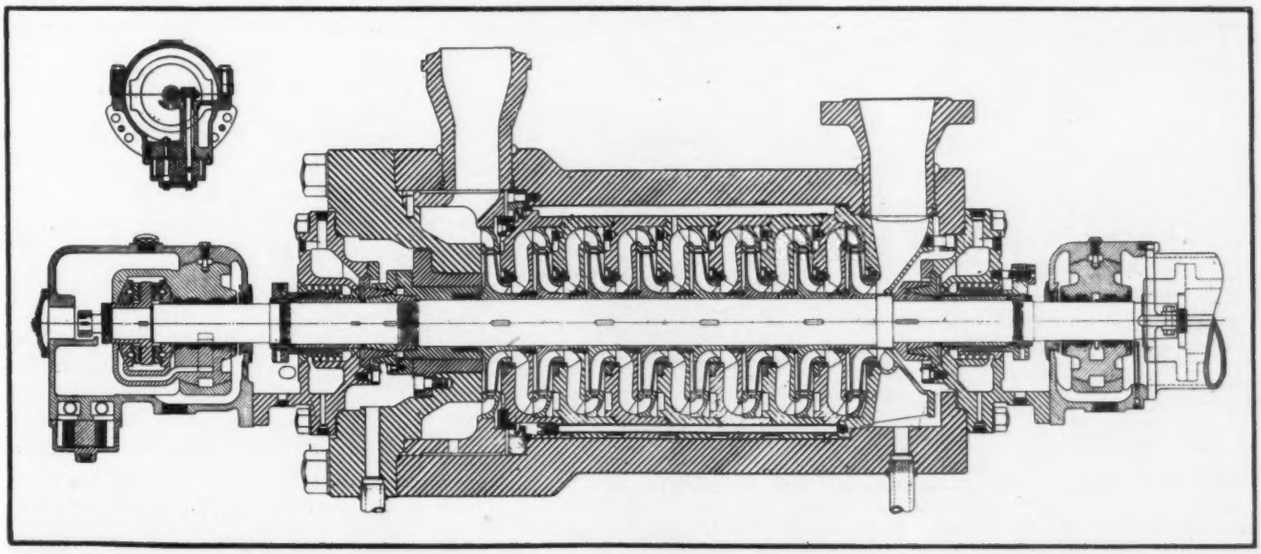
It was early realized that with high-pressure heaters the problem of tube leakage assumes serious proportions as the capacity of a drainage system, even though liberally designed, is quite limited in protecting the heater shell from excess pressure in the event of tube failure. The means available for safeguarding the heater and turbine are:

1. Closing the bleed steam valve at the heater.
2. Isolating the heater with automatically operated valves.
3. A large emergency drain valve controlled by water level in the shell.
4. Spring-loaded relief valves.

To avoid an immediate shut-down and to safeguard equipment in general, automatic by-passing of the



EACH of three boiler feed pumps is driven by 2,500-hp. motor and can carry full duty for high-pressure section of plant. Rated 2,800 psi. with 550,000 lb. per hour discharge



Bleed-Heater Data

HEATER	High Pressure	Cross-over	Cross-over Drain-Cooler	8th Stage	8th Drain-Cooler	G.S.L.O.	14th Stage
Make	F. W.	F. W.	G. R.	G. R.	G. R.	G. R.	G. R.
Steam supply stage	14th hp.	h.p.exh.	Drains	8th l.p.	Drains	Glands	14th l.p.
Steam pressure, actual max., abs	654	452	.....	96	.....	17	10
Shell pressure, design, abs.	715	495	515	135	165	40	40
Steam, B.t.u./pound	1,309	1,273	457 F.	1,335	325 F.	1,374	1,162
Steam, lb./hour, f.l.	28,000	71,000	101,000	22,000	160,000	6,000	38,000
Water pressure, design	3,200	3,200	900	900	900	200	200
Water temp. in, f.l.	445	346	324	281	267	190	89
Water temp. out, f.l.	490	445	346	324	281	217	190
Water lb./hour, f.l.	575,000	575,000	610,000	610,000	610,000	432,000	383,000
Water passes	2	2	2	2	2	2	4
Sq.ft.	1,800	1,800	945	2,200	1,090	1,210	1,800
Vert. or hor.	hor.	hor.	hor.	hor.	hor.	hor.	hor.
Desuperheat zone	yes	no	.....	yes	.....	yes	no
Drip discharge	casc.	casc.	.....	casc.	.....	casc.	pump
Terminal difference	6	12	5	1	5	2	4
Tubes, o.d.	3/4"	3/4"	5/8"	5/8"	5/8"	5/8"	3/4"
Material	Monel	Monel	Ars. Cu.	Ars. Cu.	Ars. Cu.	Ars. Cu.	Ars. Cu.
B. W. G.	13	13	15	16	16	18	18

heater was considered, but the additional cost, complications and possibility of failure to operate were thought objectionable. In any event it was thought necessary to provide relief valves as a precautionary measure.

Heater Can Be Isolated

The loss of a number of heater tubes would undoubtedly necessitate a boiler shut-down if a heater could not be isolated promptly as a large amount of feed would then be diverted from the main circuit through relief valves or by recirculation through the drainage system.

Two float switches actuated by high-water levels are provided for each heater. Their electrical circuits are in series, so that both high water and excessive shell pressure occurring simultaneously can force a feed pump outage.

Flow meters for indicating drainage flow from the eighth stage heater and the crossover heater will show at any time if flow is excessive (indicating tube leakage), so that the operator can correct the trouble without a shut-down by isolating the heaters.

The Elliott deaerator follows the precedent set at Logan and Windsor by carrying an 0.005 cc. per liter guarantee and by being generous in storage capacity.

Twin Branch Condenser No. 3

The Foster Wheeler condenser is single-pass, having 32,500 sq.ft. of surface composed of tubes $\frac{7}{8}$ in. diameter, 21 ft. effective length. The tube bank arrangement is unique in its relatively shallow depth between the steam-entering and the air-offtake sides, the steam being on the outside of an inverted "U" shape and the air-offtake within the inverted "U." It is the first of its kind so far as is known. With generous steam passages on the top and sides of the inverted "U," the folded tube bank fits into the shell, which is somewhat narrower than usual, and thus conducive to simplified design of the turbo-generator foundation. The steam passages on the sides open up to the hotwell to reheat the condensate to saturation temperature by means of an arrangement of perforated trays and thin-sheet spillover practically the full length of the shell.

Simple Steam Line

Perhaps for the first time all valves were omitted from the main steam lead between the boiler and the turbine emergency stop valve. In order to eliminate the usual gate valve between boiler and turbine it was necessary to convince ourselves that the turbine emergency stop valve would permit a satisfactory hydrostatic test on the boiler.

Following the precedent established in the design of Windsor unit No. 7, in purchasing the boiler an anchored superheater outlet was specified. While the boiler was being designed to this end, the steam lead layout began to require many bends to keep end reactions and pipe stresses within proper limits. The thought then occurred that instead of having an anchored superheater outlet, why not permit it to move. The amount of movement that had to be taken by the superheater outlet, because of the anchored turbine emergency stop valve, amounted to about 4.5 in. This movement could be absorbed through the superheater outlet pipes, required anyhow, to connect the several superheater stub headers.

Stop Valve Anchored

By anchoring the turbine emergency stop valve, and having a flexible superheater outlet to which to connect, an extremely simple steam lead was made possible. It is merely two straight tubes $7\frac{5}{8}$ in. I.D. and 11 in. O.D., one piece being 15 ft. long and the other 34 ft. $3\frac{7}{8}$ in. long. One single tube 49 ft. $3\frac{7}{8}$ in. long could have been furnished, but two pieces were used in order to insert the steam flow nozzle at the proper location. It should be noted that a $7\frac{5}{8}$-in. I.D. steam line was sufficient to supply steam for producing 76,500 kw. Obviously, the main steam piping of this installation represents the ultimate in simplification and minimum cost.

If the low-pressure turbine had been a multi-valve or nozzle-governing type instead of a single valve or throttle-governing type it would have been necessary to provide a separate pressure-reducing system as it is only a 400-psi. unit. In this case some expense was avoided by merely making the single control valve good for 600 lb. and using it to throttle the excess pressure.

Check Valves in Series

One feature of the boiler feed piping at Twin Branch (first used at Logan and then Windsor) is the use of two check valves in series at the boiler feed pump discharge. Since so much trouble had been experienced in low-pressure installations, double-checks seemed cheap insurance indeed in high-pressure plants, where the pumping equipment is far more expensive, clearances are closer, units are larger and outages far more important, and where the loss of water from the boiler back through the pump suction lines could cause havoc.

Double check valves are also installed in the tank pump discharge lines where backflow of water, with consequent loss of suction to the feed pumps, would be equally serious.

High-Pressure Functioning Relies on Automatic Controls

Comprehensive boiler, feedwater, turbine and condensate controls centralized and coordinated — Auxiliaries interlocked for sequence operation

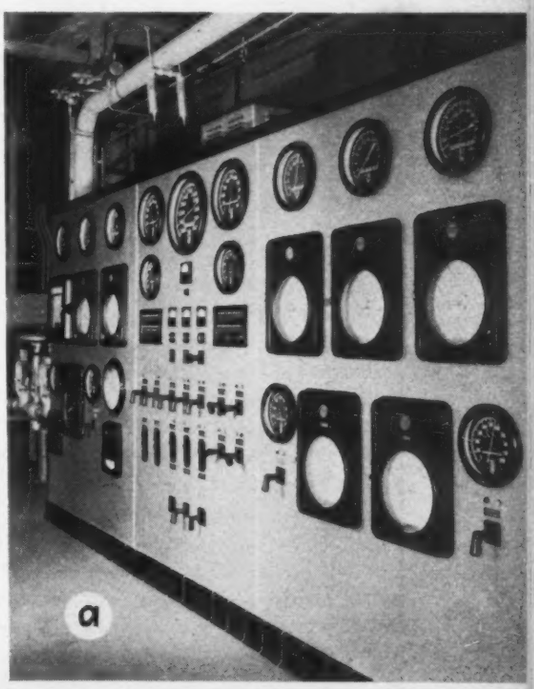
SIGMUND N. FIALA, American Gas & Electric Service Corporation

CONTROL for Twin Branch was adopted in the light of (1) the involved starting and operating cycle, (2) the controlled superheat and reheat within the same boiler unit, (3) the necessarily narrower margin of operating tolerances, (4) the greater requirements for precision of measurement and (5) coordination of operating functions.

Four control boards, namely, boiler, turbine, feed pump and condensate, were established to centralize the controls and instruments, the three first being located on the main operating floor. Telephone communication is supplemented by a public address system to make it possible for key operators at all vital points of the plant to hear instructions or discussions simultaneously. As a final line of defense and to facilitate testing and adjustment of apparatus, portable 'phone sets can be plugged into the same circuit. Switches on both the boiler and turbine control boards provided that either unit or both may be shut down from each location. Should it become necessary to trip the turbine, the turbine operator may at the same time trip the boiler and thus greatly minimize the disturbance.

Boiler Control

With exception of the coal burner ignition torches (which must be attended to locally at the burner deck) and superheater vent valves (which



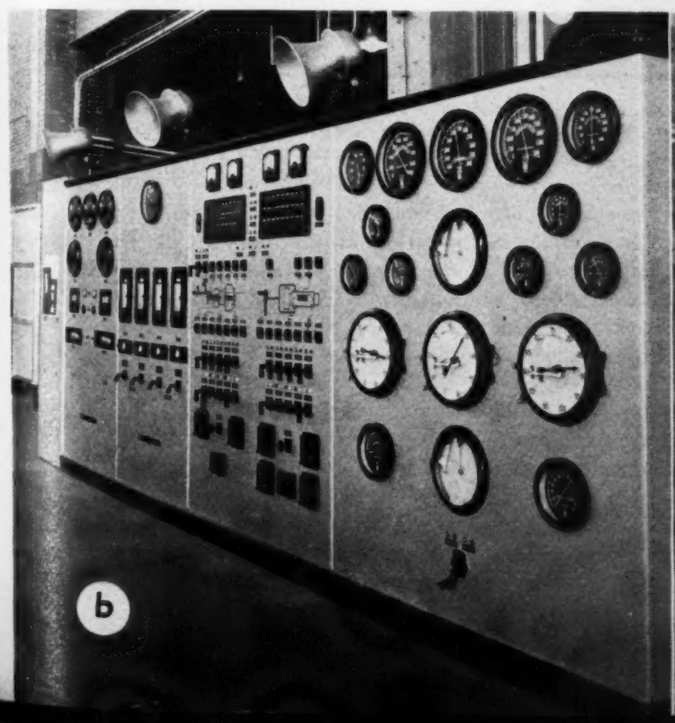


FIG. 1—Associated controls centralized. (a) Boiler control. (b) Turbine control. (c) Pump control.

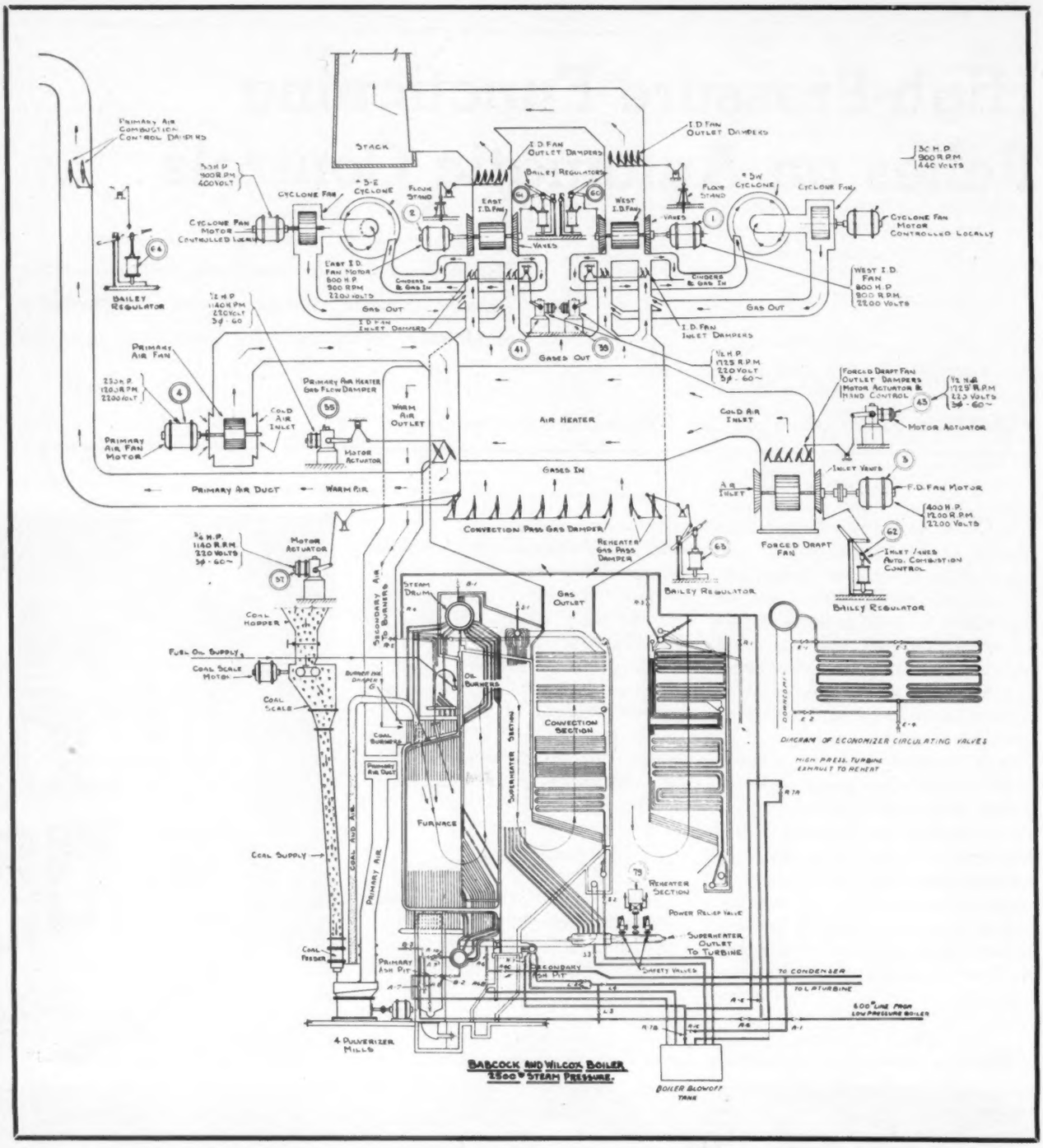


FIG. 2—Assembly of controls for fuel, air, temperature, flow and pressure makes functioning of 2,500 psi. practicable. Not shown are coal feed and primary controls located at pulverizers

may later be motorized) a complete remote control system (Fig. 1) was provided to cover starting of all auxiliary equipment and to cover every phase of boiler operation. Indicating, recording and check instruments were selected to give the operator a complete running log of operating performance, as described later. Selection, application and installation of this control equipment were governed by the fundamental requirement that no shutdowns be caused by failure of any part of such equipment. If one control fails to respond, another in sequence takes its place.

To control the elements of combustion, a Bailey air-operated system of combustion control devices is applied to the vane controls of the draft fans and the primary air damper. Profiting by past experience with sticking of fan vanes and dampers, the Bailey power pistons have been equipped with electrical position indicators (first applied to the Logan installation), consisting of uniformly graduated resistances varied by the motion of the power piston.

Damper Operation

The inlet shut-off dampers on the two induced-draft fans, the primary air shut-off damper at each of the

four pulverizers, and forced-draft fan discharge shut-off damper have been equipped with motorized actuators, with push-button stations and position indicators at the control board (Fig. 1). In addition to providing a complete back-up for the air-operated controls, these actuators serve many useful purposes. The induced-draft fan damper actuators are interlocked with the motor-starting switches, so that when two fans are in operation and one fan should fail, its corresponding inlet shut-off damper will close automatically, thus preventing short-circuiting of gases and eventual loss of load. In starting up the boiler the damper and inlet vanes are operated in series, thus giving good control in this critical range. When the load reaches the point where the second fan is to be started, this is done with no disturbance. The second fan is started with the vanes and damper closed. Then the damper is opened very gradually, giving the operator ample opportunity to equalize fan loads with ease.

Since the output of all four pulverizers is controlled from a single damper in the common primary air duct, the motorized dampers are used to cut pulverizers in and out of service and to vary fuel output division. This provision greatly facilitates pulverizer operation and burner ignition, particularly in operation of this boiler where sudden "bumps" are very undesirable.

The forced-draft fan shut-off damper actuators serve as a back-up for vane control and to facilitate air volume control in starting up.

Combustion Index

A CO_2 recorder, an oxygen recorder, a recorded measurement of the division of flow of gases through the reheater convection pass and the superheater convection pass and the total air-flow-steam-flow boiler meter, plus numerous draft and temperature indications and recordings, have been provided. All of these are needed for precise operation, but even then do not always give a full story. During the first month of operation a bad condition of coal distribution from the pulverizers existed without being detected until found by the exacting tests of the boiler manufacturer's "hi-velocity gang." The oxygen recorder is now being adapted to operate on a cycle of a number of sampling points chosen by stratification tests.

Furnace draft is indicated on two draft gages, each going to a separate connection in the furnace, one of them being parallel with the control draft. The associated high draft alarm is set to ring at minus one inch and low draft at zero.

All auxiliaries are interlocked for sequence operation. A furnace pressure contactor is utilized in conjunction with a time-delay relay to trip the boiler in the event the furnace draft goes to a value of plus one-half inch for a period of fifteen seconds.

Feedwater Control

For automatic control of drum level, the three-element type of regulator was selected with the usual feature of either remote hand or automatic selection. The control valve has an 8-in. carbon-molybdenum body of bonnetless type design. The inner valve parts are accessible from the bottom of the valve body through a breech-block-type cover-plate developed for this job. This valve possesses an exceptionally good characteristic curve, the design being based on its passing a flow of 550,000 lb./hour with a pressure drop of 75 psi. when wide open.

Shut-off gate valves have been provided on each side of the regulating valve, one of them being motorized. Thus, in the event of trouble, the regulator can be completely shut off from the control board and then, to take its place, there is provided a motor-operated by-pass globe valve with its push-button station and position indicator adjoining the other controls. Designed to give the same flow characteristics as the control valve, this valve thus gives the operator secondary means to hand control remotely the water flow at any value from zero to maximum flow. To prevent undue wear and to cover the critical range of operation while bringing the boiler up to line pressure, when as much as 2,200 psi. has to be throttled, a 2-in. hand-operated plug type valve has been bridged across the above valves. This valve is hand-operated by instructions over the portable telephone communicating system.

Bi-color water level gages have been arranged so that the operator may observe them while operating the controls at the board. Each glass gives a 12-in. vision.

There are two drum level recorders, each serving a specific purpose in addition to giving dual indication and alarm protection, one on the main control board and the second on a nearby auxiliary panel. To obtain good readability and close control for normal operation, the main recorder was designed for a fairly narrow range of operation. A pressure compensator was developed by the manufacturer to indicate correctly the level under drum pressure, over the range of 1,000 to 2,800 psi. pressure. Without it there would be about a 6-in. error if drum pressure dropped from operation level to 2,000 psi.

The auxiliary recorder, a new design of bellows type, covers the entire range of the drum. It is used during starting up when the drum is filled to the very top in order to equalize the rate of heating.

Temperature Control

One of the first problems was how to measure the temperature in main headers. It appeared desirable to eliminate thermocouple wells by substituting peened-in thermocouples for pipe surface temperature measurement. As little was known as to accuracy and time lag of such a method, a series of tests (Fig. 3) were conducted in one of the company's 1,250-psi., 925-deg. plants. Although these readings and subsequent check tests indicated more than adequate accuracy for commercial operation, there was sufficient doubt raised regarding the mechanics of installation and life of thermocouples to warrant further research. After careful consideration, it was decided to use the wells for several of the important measurements and peened-in couples for check points. The wells, manufactured in the company's machine shop, are of Columbian stabilized stainless construction.

Final primary steam temperature and the reheated steam temperature are recorded on double-range potentiometers in order to give good readability during normal operation and at the same time to cover adequately the starting-up period. Starting-up range, indicated by a green signal light, is from 0 to 800 deg. and the operating range, indicated by a red

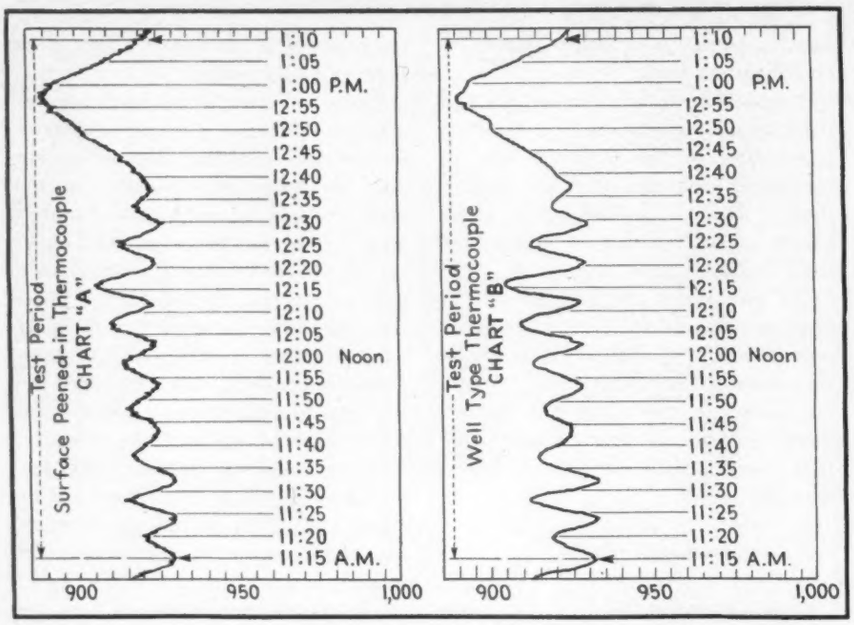


FIG. 3—Tests made to fix choice between alternative methods for measuring temperature of 2,500 psi. steam. (A) Peened-in thermocouple. (B) Well-type thermocouple

light, is from 700 to 1,100 deg. Control features have been incorporated in these instruments to adapt them for temperature regulation systems, described later.

Extending the practice that was established at Logan and Windsor high-pressure installations, an 80-point Leeds & Northrup potentiometer has been incorporated on the control board. For quick identification, colored handles are used for grouping closely related temperatures. Safe operation of the boiler without this instrument would not have been possible. To provide still greater safety of operation during the initial period and to obtain research data, a very extensive temporary installation of thermocouples was made by the boiler manufacturer. Some of these functions will be later permanently wired to the spare points on the indicator.

Temperature Regulation

To aid the control of rate of change of operating pressure during starting up or shutting down in accordance with steam-drum thermal stress requirements, and to give a graphic record of this procedure, a six-point temperature recorder has been provided. Two of the points measure the temperature of water in the downcomers and the four others the external surface of the steam drum.

Final primary steam temperature is regulated by means of an air-operated three-element attemperator control equipment (Fig. 4). Reduction in temperature is obtained by spraying high-pressure feedwater through five nozzles into a 15-in. O. D. section of the pipe connecting the first and second stages of the superheater.

Design, arrangement and proportioning of the spray nozzles is the product of extensive research by the boiler manufacturer, confronted not only with proper atomization (to give wide range and smooth temperature regulation), but also with prevention of high stresses due to temperature shock. Adequate provisions have been made to take care of both of these conditions.

A motor-operated regulating globe valve has been provided as a by-pass around the spray water control valve for emergency operation, and the rest of the control system is arranged so that it may be hand-operated even under the extreme condition of a complete loss of control-air supply.

The three-element control principle has been applied to the attemperator temperature-regulating system. Water flow to the attemperator nozzles is proportional to the boiler output and the result is corrected by the value of the final steam temperature. Some anticipatory action is thus provided when operating under varying load conditions. Minimum and maximum differential pressure across spray nozzles is used for automatically cutting in or out the number of nozzles in accordance with the set sequence. All valves are of the no-bonnet type construction.

Reheat Temperature

Final steam temperature from the reheat section of the boiler is regulated automatically or manually by actuating the gas dampers above the reheater convection pass. The gas dampers above the superheater convection pass have been connected to a motorized actuator for remote hand positioning as required in order to keep the reheater damper in control range. Both dampers have been designed to give a predetermined flow characteristic necessary for good control. A spray type desuperheater was also provided in the reheater inlet piping in order to broaden the range of control.

Better to define the routine starting-up rate-and-time cycle, flow meters are provided to indicate (1) flow of steam to hydrokineter, (2) the amount of cooling steam to reheater and (3) quantity of oil to ignition burners. These burners are of sufficient capacity to bring the turbines on the line at design pressure.

Ahead of the power-operated relief valve is a globe type shut-off valve. The globe type valve was selected in order to permit throttling of appreciable steam flow under the hot-turbine starting condition, thus enabling heavy enough firing to bring the primary steam temperature to the required value.

Pump Control Station

The pump control board centralizes the operation of the high-pressure portion of heat cycle from the deaerator to the boiler feedwater control valves. Here are located the controls for adjustable speed tank pumps and high-pressure boiler-feed pumps, heater drainage, cycle temperatures, flows and a complete system of alarms.

Automatic pump control has been provided to maintain feedwater pressure within close limits to realize the benefits of adjustable-speed operation for best economy. A special duplex suppressed-range pressure gage was developed to give conveniently close indication of the differential pressures. An interlock for the protection of boiler feed pumps

against loss of suction pressure has been provided in the form of pressure contactors which trip motor breakers when this pressure reaches a predetermined low point.

As a further protection of high-pressure boiler feed pumps against overheating due to sudden reduction of load, an emergency leak-off control equipment has been provided. Low flow contacts in the suction flow meters automatically open the leak-off control valves, thus establishing safe minimum flow.

Arrangement for throttling of pressure from about 2,800 lb. to nearly atmospheric pressure presented an interesting problem. In order to preserve tightness of the control valves for normal operation, stainless-steel nozzle assemblies were designed to take the brunt of punishment. Additional stainless-steel wear-fittings and anti-flashing nozzles complete this installation. This combination has given a good account of itself.

Turbine Control

A complete system of supervisory control has been provided for the turbo-generator unit. The various devices are grouped on the control board around a mimic diagram of the turbines along with the indicating and recording instruments. With the exception of the stop valve drains, shell drains and several packing seal and leak-off valves, the operation of all functions is remote, including, for example, such operations as stop valve test. The load on the units may be controlled by either the switchboard or the turbine operator.

Remote indicating and recording instruments and alarms provide for constant policing of the turbo-generator unit. A total of about sixty annunciator alarms is employed for this purpose, covering such items as hydrogen cooling system, bearing oil temperatures, bearing vibration, shaft eccentricity, and many others.

A differential expansion recorder was provided for the initial period of operation to give a graphic record of the behavior of the high-pressure turbine under the varying conditions of temperatures and load. From these records of expansions and contractions a well-defined program of starting procedure was established giving the operator an entirely safe zone of operating tolerances.

The low-pressure portion of heat cycle—that is, that portion of it from the condenser to the deaerator —is centralized on the condensate control board. Piping has been arranged to make it possible to group hand-regulated valves around this control station. That, coupled with remote starting of pumps, alarms, indicating and recording instruments, gives the operator an almost visual coverage of this portion of the plant.

No Short-Notice Shut-Downs

Control boards are finished in silver gray color, with locations of equipment dictated by sequence of operation rather than appearance or symmetry.

Alloy-steel tubing, coupled with new type of flareless compression fittings, is utilized for all high-pressure instrument piping. After erection all this tubing was subjected to a hydrostatic test of 5,000 lb., so that no leaks were experienced when the plant was placed in operation.

Within the first 24 hours of the initial starting period the operating pressure was brought to the highest popping valve pressure of 2,700 psi. at about one-half load output. The subsequent period of almost six months of commercial operation, during which no short-notice forced shut-downs were experienced, well illustrates the contribution of coordinated control of operation.

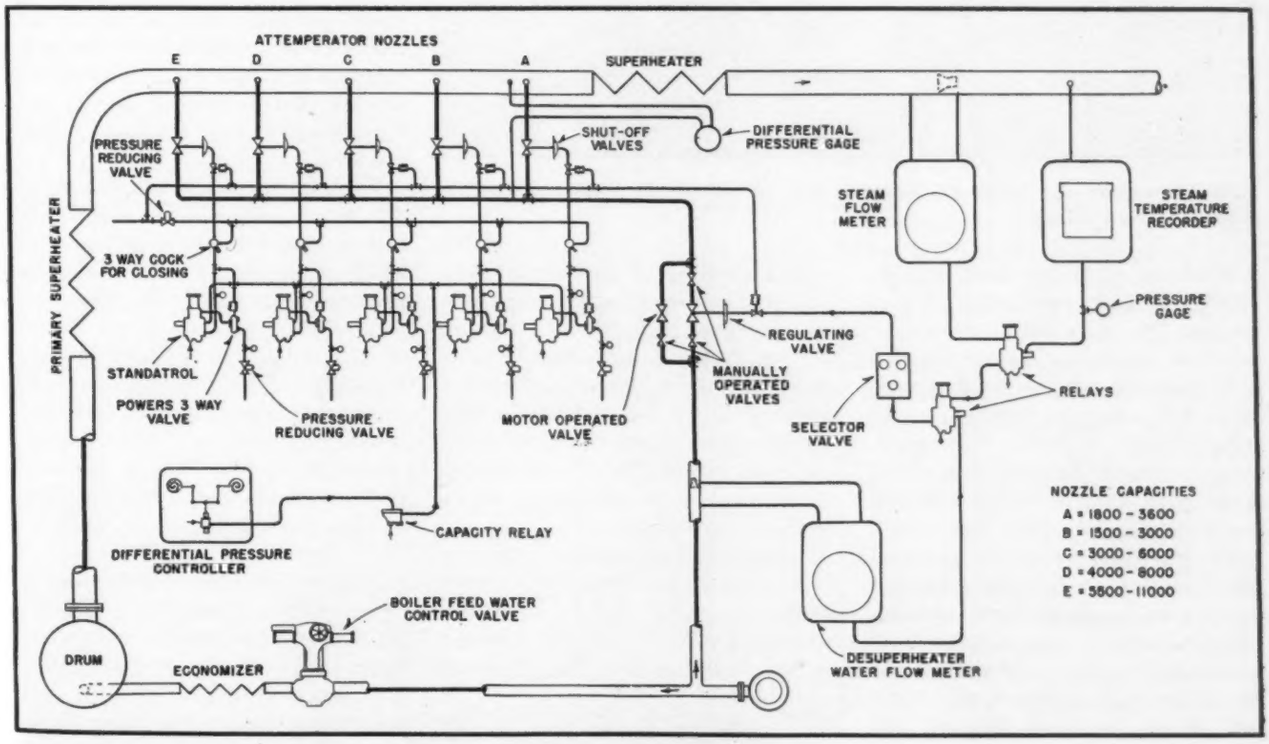
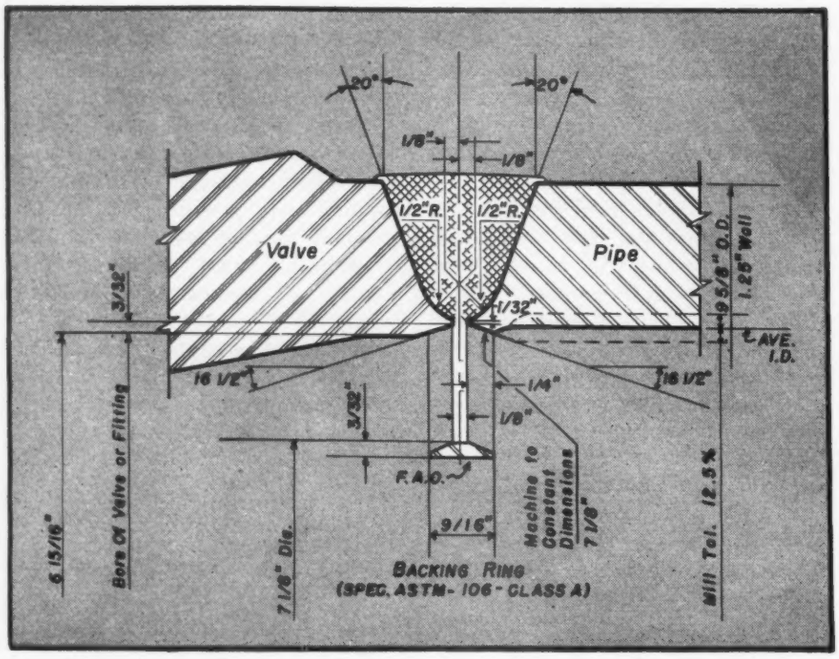


FIG. 4—Superheat temperatures controlled by means of regulator attemperator

Pipe Welds and Valves for Twin Branch 2,500 Psi.

Three welds and no valves in boiler-to-turbine line — New check valve and bonnetless valve for boiler-feed service — Critical welding inspection

G. E. SONDERMAN, American Gas & Electric Service Corporation



BEVELED backing ring added to "Amgael" joint (developed for Windsor station) to conform to Boiler Code

WHILE the requirements of 1,250-lb., 925-deg. F. steam installations during the last few years led to the almost universal acceptance of carbon-molybdenum steel for main steam piping, there was a serious question of the suitability for 2,500-lb., 940-deg. F. steam piping at Twin Branch. Final decision to continue the use of carbon-molybdenum steel was based chiefly on the fact that the increased cost of higher strength alloys was not justified by the gain in creep strength obtainable. This was coupled with some uncertainties about the properties of the higher strength alloys and lack of experience in bending and welding them, whereas the metallurgical knowledge of carbon-molybdenum steel had been greatly augmented by experience gained in 1,250-lb., 925-deg. F. installations. Based on this knowledge, a very rigid specification was written for the carbon-molybdenum steel embodying requirements to control grain size, grain structure and the elimination of undesirable metallurgical characteristics.*

Design of main steam piping was then based on an allowable stress of 8,400 psi. at 940 deg. F., using the modified Barlow formula as required by the Boiler Code. The resultant tubing was 11 in. O.D. by 7⅝ in. I.D. and was made by turning and boring a solid forging. This process obviated the need for the usual plus or minus 12½ percent wall thickness tolerance required in making pierced and drawn tubing, which tolerance in this case would have resulted in nearly ¼ in. thicker nominal size tubing. Furthermore, the tubing was produced with a machined finish, thus removing all question of scale and surface defects.

Moly Steel

Carbon-molybdenum steel was also used for the reheat piping, operating with 400-psi., 900-deg. F. steam. Under these conditions the then current A.S.T.M. specification A206-39T was considered adequate and 12¾-in. O.D. by ½-in. wall thickness tubing was used.

While the maximum temperature of 495 deg. F. indicated the use of carbon steel for boiler feed line, the 2,600-psi. pressure made necessary an especially heavy wall tube. However, pump shut-off pressure for the motor-driven feed-pumps becomes as high as 3,200 psi. Final selection was based on the maximum expected operating pressure of 3,000 psi., with thickness calculated by the Barlow formula. This resulted in specifying Grade B seamless steel tubing 9⅝ in. O.D. by 1¼ in. thick.

For the small sizes of high-pressure piping, such as drain and instrument connections, the double extra-heavy standard was found adequate either in carbon-molybdenum steel for high steam temperatures or in Grade A carbon steel for boiler feed service.

* See paper by E. H. Krieg and G. Sonderman, "The Selection and Application of High Temperature Piping Material," November, 1939, issue of *Welding Journal*.

The balance of the piping installation used principally seamless steel tubing to A.S.T.M. specification A106. One notable exception was the use of "Cor-Ten" steel for the 36-in. O.D. atmospheric relief stack.

Smaller sizes of low-pressure, low-temperature piping (service water, vacuum, vent lines, etc.) up to and including 1½-in. size were run in copper tubing.

"Amgael" Joint

In 1939 the Boiler Code made mandatory the use of backing rings for welded steam piping joints coming under its jurisdiction and consequently the "Amgael" joint developed for Windsor station was modified by inserting a small beveled backing ring between the abutting lips, but retaining the full thickness weld features.

The modified "Amgael" joint was used for main steam, reheat steam and boiler feed piping and was entirely successful in field application.

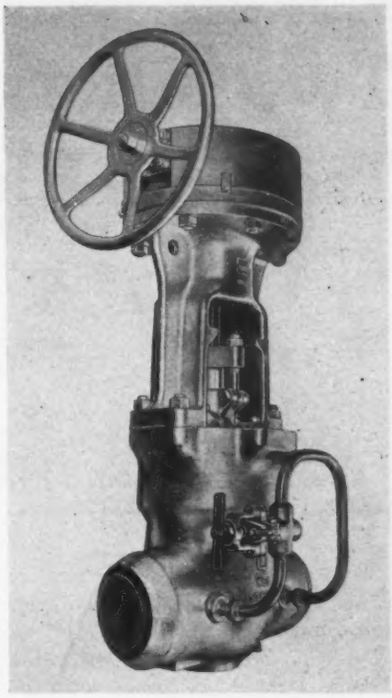
For the small sizes of high-pressure piping all joints were socket welded. Some unfortunate experiences had been encountered on the American Gas & Electric Company system with poor socket welding where the weld had inadequate throat thickness. In order to reduce this hazard it was decided, for the Twin Branch job, to counterbore the ends of socket welding fittings and valves to a depth of ⅛ in., thus giving a greater throat dimension and length of fusion line between the fillet weld and the pipe.

Welding inspection requirements were met with what is known as the "man-to-man" system. One inspector assigned to each welder constantly checks (by observation and recording voltmeter and ammeters) the quality of each weld deposit, the cleaning and removal of defects from each bead or layer and the maintenance of proper preheat. The inspectors are experienced welders trained to detect the deposition of unsound metal by observation of the arc and with the aid of supervisory instruments placed in the welding circuit.

Gamma-ray inspection was applied to the three welded joints in the high-pressure system. Fortunately it was possible to introduce the radium capsule for the center joint through the end of the pipe. For the closing welds the capsule was inserted through the turbine stop-valve (by removing the cap) and through a safety-valve nozzle, and no extra holes were required. No defects were disclosed. No other use was made of gamma-ray or X-ray inspection for pipe welding.

Valves

Investigations of valve failures resulted in the development of the "Twin Branch" 2,500-psi. valve, which marks another interesting advance in high-pressure steel valve design. There are no main steam valves between the single boiler and turbine except those supplied with the turbine. The chief valve problem came in the boiler feed system. Here both gate and globe valves were required to close against 3,200-psi. water pressure at 495 deg. F. The use of stellite surfaced welded-in trim has had wide acceptance for severe service conditions and was quickly decided upon. The bonnet-joint problem was the most difficult.

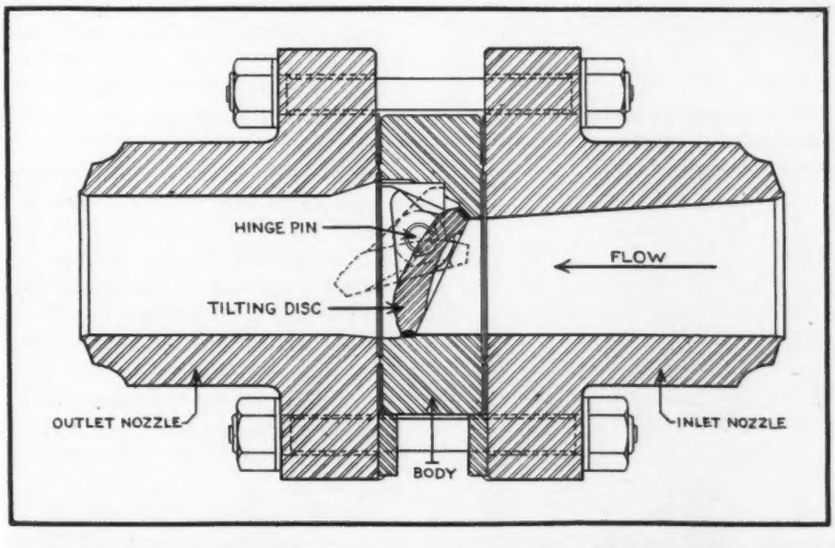


BREECH-LOCK seal-welded bonnet joint for 8-in., 2,500-psi. gate valve for boiler-feed line. Bypass line has bonnetless valve typical of designs used on small valves elsewhere on 2,500-psi. system

A thorough study of various types of joints led to the development of the "Twin Branch" breach-lock seal-welded bonnet joint for the large Lunkenheimer valves.

Design of the Chapman check valve for high-pressure boiler feed service also produced innovations. The tilting disk type of check valve at Logan and Windsor has proved advantageous due to its positive, quiet closing action and low-pressure drop. By providing a stop holding the disk slightly below full open position, flutter of the disk and consequent wear at the trunnion are eliminated.

In attempting to work out the conventional diagonal flange, which is customary in all tilting disk valves up to 1,500-lb. pressure standard, for the maximum pressure of 3,200 psi., difficulties were encountered in the way of a tremendously heavy casting and lack of bolting space. It was then decided to redesign the valve arrangement completely, yet retaining the tilting disk principle. The new design called for welding ends, all-welded stellited trim and ready disassembly for maintenance.



TILTING-DISK check valve used in tandem on feed-line for 2,500-psi. boiler at Twin Branch

Two Alternator Units Treated Electrically as One

No generator bus — Fully excited units synchronized as one — Auxiliaries fed from step-up transformers — Extensive differential protection is provided

F. A. LANE, American Gas & Electric Service Corporation

BOTH of the new Twin Branch generator units are tied directly to the 132-kv. bus without the intervention of any low-voltage buses and the auxiliary power is supplied from a fourth winding in the outgoing transformer (also feeding local 27.5-kv. system).

The No. 3 high-pressure element is a 3,600-r.p.m. machine rated 22,500 kw. at 0.8 power factor and the low-pressure section unit is an 1,800-r.p.m. machine rated 54,000 kw. at 0.9 power factor. Each has direct-connected 250-volt exciters, rated 100 kw. for the high-pressure and 175 kw. for the low-pressure machines. Each exciter is controlled, in turn, by a 4-kw. direct-connected pilot exciter.

Both generators are hydrogen-cooled at ½ lb. above atmospheric pressure. Previous installations have had separate vacuum-treating systems, but at Twin Branch the installation has a single vacuum treatment for both machines. All of the hydrogen-cooling auxiliaries have been combined in a single unit. This package assembly has greatly simplified the installation of the equipment.

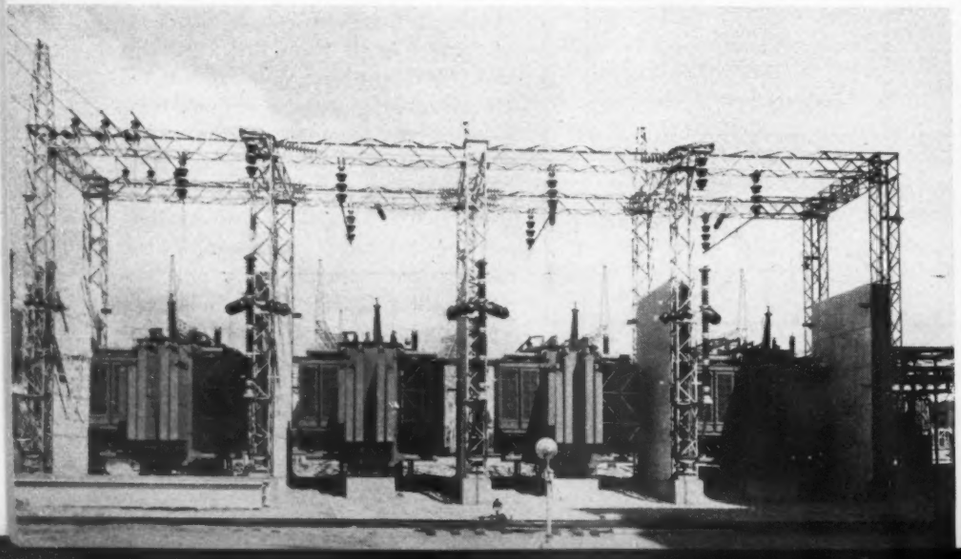
Generator coolers have been so arranged that they may be serviced from the ends of the machine without in any way interfering with other portions of the installation.

Temperature recorders have been installed on the fields and on the stator temperature coils. A surge protector unit, consisting of a capacitor and lightning arrester, has been installed at the junction of leads from both generators to eliminate the possibility of damage to the windings from impulses propagated through the 11-kv. winding of the transformer.

The Westinghouse multi-winding transformers are of the conventional oil-insulated, self-cooled type, with auxiliary blowers for obtaining their full rating. The 11-kv. winding is connected in delta and has an air-blast capacity of 90,000 kva. The 30,000-kva., 27.5-kv. winding is also connected in delta, as is the 16,000-kva., 2,300-volt winding. The 80,000-kva., 132-kv. winding, however, is connected in wye and solidly grounded.

The 132-kv. winding is designed with 115-kv. insulation. Arresters for protecting the transformers are mounted directly on them for the 27.5-kv. and the 2,300-volt windings. Those for the 132-kv. winding are mounted immediately adjacent to the transformers. There are no arresters directly on the 11-kv. winding.

FOUR-WINDING, step-up transformer bank arranged so spare unit may be substituted without moving. Simple fire walls consist of transite sheets on opposite sides of supporting columns between transformers. Arresters mounted directly on or immediately adjacent to transformers



Main Switching

Unit No. 3 has been set up to be electrically independent of the original generator installation. High and low-pressure generator units are tied together by means of disconnecting switches. Connection from this joint tie to the 90,000-kva., 11-kv. winding of the four-winding transformer bank is through a 4,000-amp., 15-kv. oil circuit breaker.

Prior to the installation of the No. 3 unit there was no connection between the 132-kv. and the 27.5-kv. systems at Twin Branch. Because of phasing requirements it was necessary that the 27.5-kv. winding in the No. 3 step-up transformer be connected delta. This necessitated grounding the 27.5-kv. system by means of a 2,000-kva. three-phase grounding transformer sufficient for relaying purposes.

For the auxiliaries, the unit system has been adhered to. As noted previ-

ously, a question arose as to whether a separate auxiliary transformer should be provided, and as a result of studies the capacity was arranged for in a fourth winding of the main power transformer. The size of the main transformer, however, made it necessary to incorporate more capacity in this fourth winding than was required for auxiliary purposes. This set-up resulted in greater short-circuit duty than could economically be provided for in the auxiliary breakers themselves and a current-limiting reactor, having a three-phase rating of 2½ percent reactance on a 10,000-kva. basis, was placed in series with the 2,300-volt transformer winding.

Emergency power for the No. 3 unit auxiliaries was established by connecting the 2,300-volt auxiliary bus to the 2,300-volt side of the 7,500-kva. step-up transformer in the 27.5-kv. station by means of three three-conductor cables buried in the ground. The main function of this transformer is to handle the output of the Twin Branch hydro station with six generators having a total capacity of 8,075 kva. Thus. this emergency auxiliary tie is also connected directly to the hydro station bus.

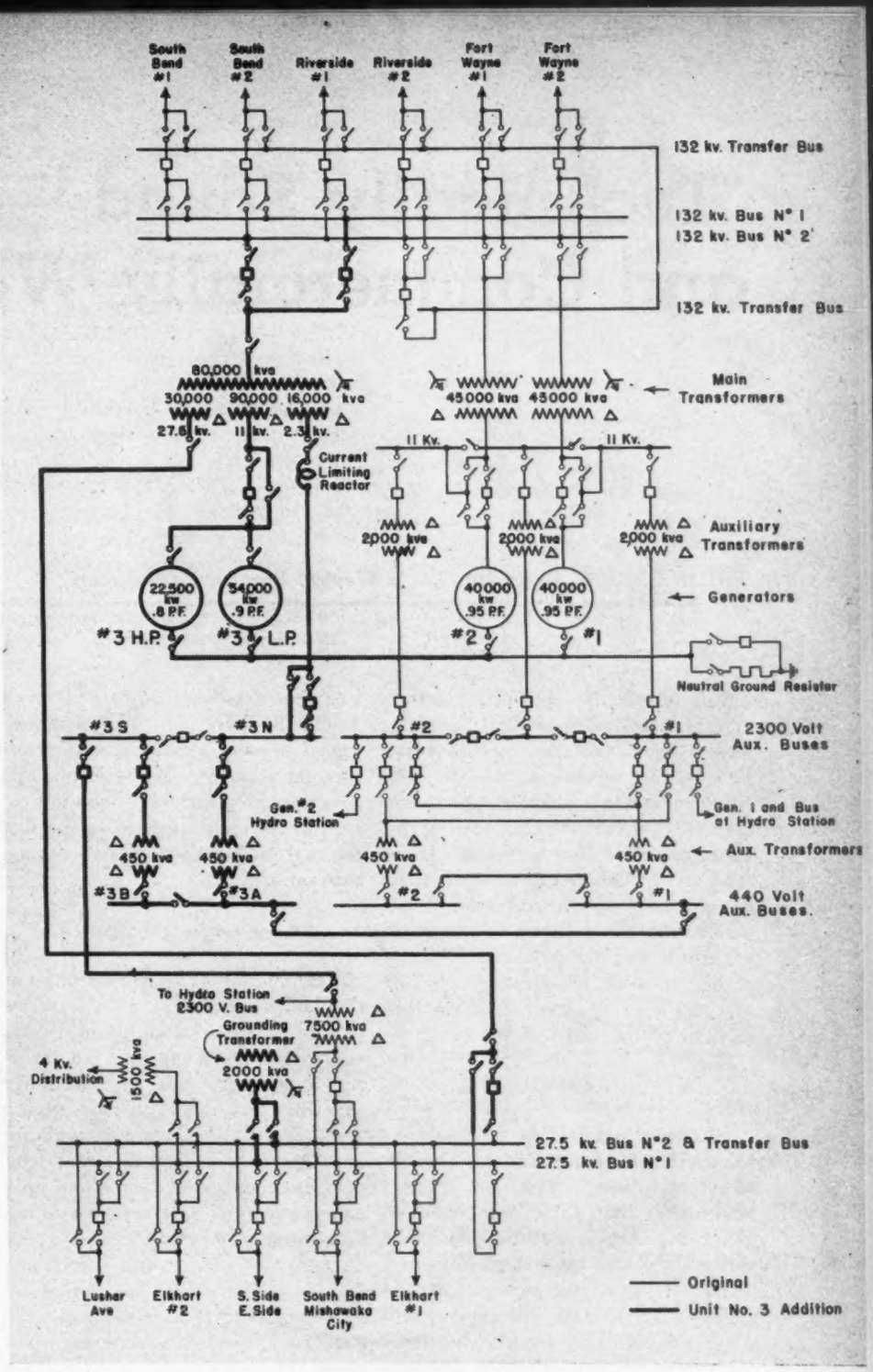
Each auxiliary bus is arranged so that cessation of its normal source of supply through transformer failure results in tripping of its normal supply breaker followed by automatic closure of the emergency supply breaker.

Motor drives and controls of all major auxiliaries were kept as simple as possible. Squirrel-cage induction motors were used except for two 800-hp. tank-pump drives which utilize wound-rotor induction motors.

Excitation, Control, Protection

In starting, the two generators are tied together electrically and excited with normal no-load full-field current before steam is fed to the turbines. Both machines are brought up to speed and synchronized as a unit to the transformer by means of the 4,000-amp. breaker. A 250-kw. motor-generator exciter set with a 5-kw. direct-connected sub-exciter is provided for starting unit No. 3 and can also serve as spare excitation.

Each of the 132-kv. main buses is protected differentially, so that in case of trouble only half of the 132-kv. feeders and one 40,000-kw. generator will be affected. Generators of unit No. 3 have direct differential relay protection. A differential relay system has also been installed to include everything from the bus side of the No. 3 transformer 132-kv. oil circuit breakers to the neutral connections of the generators. The four-winding transformer bank has its own individual differential relay protection. The 27.5-kv. bus sections are protected by differential relays so that, as in the case of the 132-kv. bus sections, service will be maintained on one bus, should an accident befall the other. The 7,500-kva. transformer bank, stepped up from the 2,300-volt hydro station bus to the 27,500-volt bus, had its own differential relay protection, and this was extended to include the emergency cable connection to the unit No. 3 auxiliaries. The set-up subjects the entire system to thorough coverage with differential relay protection.



UNIT SYSTEM is basis of electrical set-up. Simplification of connections and elimination of unnecessary switching have been sought

"Technically Sound and Commercially Workable"

Twin Branch operating performance proves quality of the decision on 2,300 pounds for turbine and natural circulation for boiler at 2,500 pounds

PHILIP SPORN, American Gas & Electric Service Corporation

TWIN BRANCH STATION'S extension at 2,500 psi. was first placed in service late in March of this year. Except for several simple though time-consuming corrective steps it has been in continuous commercial operation at the design pressure. It is true, as will be described later, that the primary superheated-steam temperature is not quite up to designed performance. The deficiency of some 80 deg. in steam temperature is being reflected in a temporary way in the thermal performance of the unit.

Availability

Combined availability of the unit for the entire first six-month period of operation was 72.5 percent. Of the total outage time 43 percent was due to the high-pressure turbine and 57 percent due to the high-pressure boiler. The combined availability for the last three months is, however, up to 88 percent, with every indication that the unit will continue in service until such time as we are ready to make the previously mentioned modifications in the arrangement of boiler heating surfaces. Except for short periods of time when loads were limited by bearing vibration of the high-pressure unit, the plant has operated at an output ranging from 50,000 to 75,000 kw., with the average for the entire period of operation being about 60,000 kw., or close to 80 percent of the design capacity of the unit.

Within the first 48 hours of the initial period of operation this higher operating level of 2,300-lb. pressure was viewed as commonplace an affair as 600-lb. operation. A prompt feeling of security about circulation was brought about by early evidence that the circulation ratio was definitely exceeding the calculated values and that the real problem was to be temperature control.

Temperature Distribution

Examination of the cross-section of the boiler unit gives an impressive picture of the difficult problem that confronted the designers. To incorporate in this unit the necessary superheat and reheat surfaces giving a 940 deg. F. final steam temperature and 900 deg. F. reheat steam temperature required a unique and bold arrangement of surfaces. To attain these final steam temperatures under the estimated variations in heat transfer rates, that would be caused by slag formation, radiant surfaces were installed in the first and second open passes.

Slag formation and distribution and, therefore, heat absorption and distribution between various surfaces, did not, however, follow the anticipated course and this brought about what proved to be the only serious difficulty with the boiler. This, however, is definitely not a difficulty connected in any way with high-pressure boiler design and operation. Rather it is due to a lamentable lack of knowledge on the behavior of ash-bearing fuels. The recently organized special research committee of A.S.M.E. is a long past due recognition of this lack and, it is hoped, also indicative of a determination to do something to remedy this deficiency.

Slagging Trouble

Trouble occurred first at a load of about 50,000 kw. At this point the reheat steam temperature reached 900 deg. F. and the thermocouples on the carbon-steel reheater tubes of the first and second open passes indicated excessive temperatures. In addition, the total heat absorption of the reheater was such that its correction was beyond the available control range. Expected accumulation of slag on these reheater walls did not take place. Furthermore, load could not be increased to speed up the slagging due to excessive tube temperatures. The unit was, therefore, shut down and the reheater walls were covered with a thin shell of refractory material by Guniting these surfaces with "baffle mix." This was done to give the slag a better chance of adhesion and also to permit increased boiler output and thus to speed up the rate of slag accumulation on the reheater tubes forming the side walls of first and second open passes.

Load Reduction Sheds Slag

Upon returning the unit to service, it was found that although the slag accumulation was accelerated as expected, a reduction of load on one occasion caused shedding of the slag and again hot tubes developed.

In order to correct this condition the unit was shut down again and studs were welded on the reheater

tubes to give a better adhesion for the "baffle mix." It was recognized that the insulation of this reheater surface was a temporary expedient. Naturally this could not be carried out to the extent of giving correct reheat steam temperature at full output without a detrimental effect on other parts of the boiler. Thus, in addition to the further corrective steps described later, an indirect method of holding down the temperature of reheated steam had to be adopted.

Holding Temperature

This was accomplished by temporary sacrifice of about 60 to 80 deg. in temperature of high-pressure steam to the turbine. Even then, at loads of more than 70,000 kw., it was found necessary to have the gas by-pass damper over the reheater-convection-pass in an almost fully closed position to hold down the reheat temperature. Resultant exclusion of considerable economizer surface above this damper caused localized steaming in that portion of the economizer above the convection superheater. Drum level disturbances that followed this steaming caused sufficient carryover to produce a rise in the first stage pressure of the high-pressure turbine.

Carryover

About this time a non-uniform distribution of coal to the burners was discovered and determinations by the manufacturer's "high-velocity" test-group indicated that this unbalanced firing condition was also a contributing factor to the excessive carryover. Fuel distribution was found excessive in the superheater lane and this, combined with the excessive bypassing of gases from the reheater lane, produced an unbalance in drum level that submerged some of the cyclone separators. Spot tests of saturated steam indicated conductivity values as high as 70 micro-ohms during extreme cases of drum level fluctuations. This condition was remedied considerably by balancing the coal distribution and by lowering the operating point of the water level in the steam drum.

Slagging—Remedial Step

During the run abnormal accumulation of slag was experienced in the second open pass. Reheater tubes forming the hopper were damaged externally by large masses of slag falling into the hopper. The unit was shut down for the third time for further corrective measures. Toward eliminating the steaming in the economizer, further insulation of reheater tubes in the convection pass was resorted to in order to permit greater gas flow through the reheater pass and thus better apportion the flow of gas through the divided boiler paths. Steel armor plates were placed on the reheater hopper sections (1) as a protection against falling slag and (2) to reduce the heat input into this reheater surface. To provide a better means for the control of and to prevent slag accumulations, telescopic soot blowers and a slag drip were installed in the second open pass. These modifications permitted the unit to operate up to its full design load.

Baffle Burning

However, full-load operation disclosed new trouble that necessitated lowering the output to about 80 percent of rated load. At loads of more than 70,000 kw. small sections of chrome ore in the water-wall baffle between the first and second open pass burned through. A temporary patching repair was made, which has proved to be satisfactory under the limited-load operation. Short peaks of higher load are of course possible and are taken advantage of; however, it is not planned to operate the unit at such rates continuously until final corrective steps previously described are completed.

Dropping of large pieces of excessive slag accumulations at the top of the second open pass to the hopper below is still giving some anxiety. But the situation is being kept well in hand by control of combustion and by occasional load decreases at night.

Control of Blade Deposit

Control of boiler feedwater and steam purity, of carryover and turbine blade deposit are matters of experimental study. Whether the original accumulations were caused entirely by boiler drum disturbances following steaming in the economizer or were caused in some part by carryover attributable to actual steam solution (as advanced by Spillner), these were sufficient to increase the first stage turbine pressure approximately 140 psi. above the normal value with clean blades. When the boiler unit was shut down for modifications these deposits were washed out by filling the shell half full with cold condensate and rotating the turbine rotor with the turning gear. The increases in concentrations of the water during the first washing were as follows:

Constituent	Parts per Million
OH	29
PO_4	9
C_l	1
SO_4	113
SIO	106
Dissolved solids	376
Suspended solids	14

Two subsequent washings showed the same constituents but successively lesser concentrations. From the measured quantity of wash water it is estimated that the quantity of solubles removed as deposit from the turbine buckets and nozzles amounted to about ½ lb. When the high-pressure turbine was returned to service the stage pressures were again normal, indicating that the deposits had been removed. The very gradual accumulation still taking place in the last few stages of the high-pressure turbine has proved amenable to washing.

Bearing Instability

Excessive bearing vibration caused by instability of the high-pressure turbine rotor in its bearings first took place within two days of the unit's initial operation and at approximately half load. This condition was corrected by altering the oil flow in the bearings and the trouble seemed to have been solved. However, after several weeks of continuous operation at loads above 70,000 kw., the bearing vibration recurred, taking place only at these high loads. This proved to be the phenomenon of "oil whip" encountered on lightly loaded high-speed bearings. Bearing alterations were also made to assure a more positive oil pressure and the unit has since been operating satisfactorily under all loads.

Both low- and high-pressure machines have been in continuous operation with hydrogen cooling of generators.

As described elsewhere, the low-pressure turbine was arranged to operate on the surplus 600-psi., 700-deg. F. steam available from the old plant. Early installation of this element permitted its operation on this surplus steam for about seven months prior to completion of the 2,500-psi. plant. Operation of this low-pressure turbine both over this period and the

operation with the high-pressure unit has been without mishap.

Operating flexibility in bringing the high-pressure turbine on the line and in shutting down was the source of some early anxiety. Due to the lightness of the turbine rotor and close inner clearances, the allowable difference in expansion between the rotor and the shell needed to be held within closer limits than first anticipated or desired. However, after careful studies of several subsequent starting and shutting down cycles a thoroughly well-defined procedure was established.

Starting from cold, the unit is brought up to a load of 60,000 kw. at 2,300-psi. pressure in about eighteen hours with ease. This starting cycle has proven conservative and can probably be shortened materially with full safety.

Pumps and Heaters

A major concern in the design period over the auxiliary equipment centered about the high-pressure boiler-feed pumps and the 3,200-psi. high-pressure heaters. The heaters have given no trouble and the carefully developed procedure for placing them in and out of service, necessary to maintain tightness of tubes in the tube sheet, is proving entirely practicable. It is further being refined to simplify hot starting.

Some minor trouble was experienced with the high-pressure boiler feed pumps, none, however, resulting in plant outages nor being attributable to high-pressure design. In order to give a compact layout, the lubricating system was incorporated in the design of the base plate and the oil reservoir and channels for returning oil from bearings were welded integrally with the base plate. Welding scale and grit lodged on some inaccessible inner surfaces were responsible for several cases of scored bearings while testing pumps before boiler went into service.

Thermal Performance

Sufficient operating experience has not yet been obtained to permit a detailed discussion of thermal performance of this unit. It is necessary to remember, also, that performance is being materially affected by the reduced primary steam temperature. However, to give the drift of performance, the ensuing tabulation covers two periods of operation as reported by the operating department. There is, further, every indication of substantial improvement:

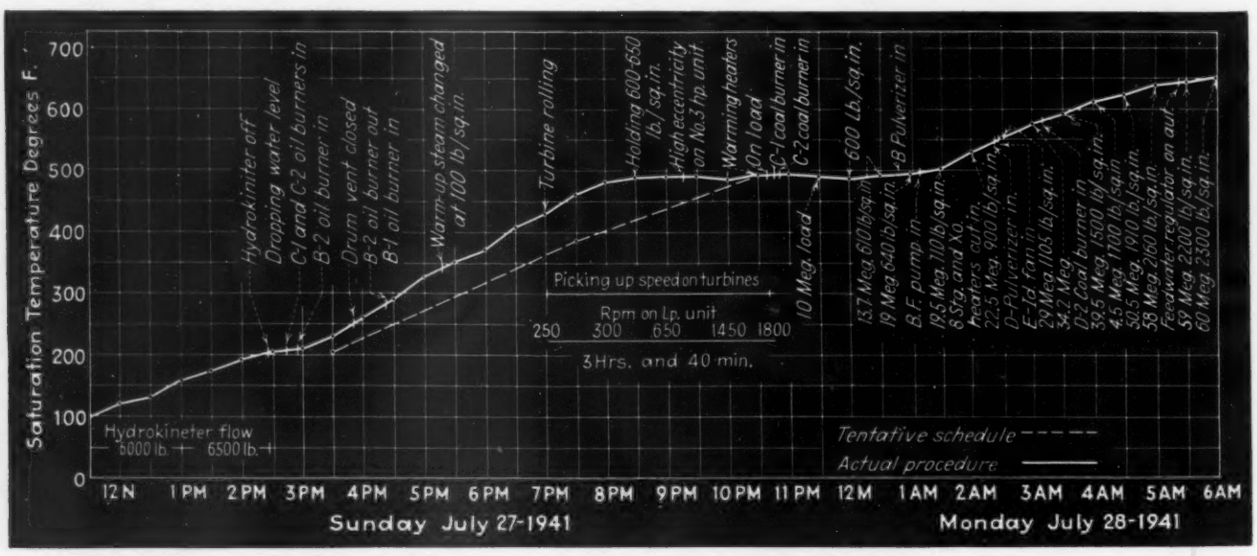
	Accumulative 622.83 Hours May 12 to June 6, 1941	Accumulative 168 Hours June 24 to June 30, 1941
Kw.-hr. generated	32,236,000	11,092,000
Avg. kw. generated per hour	51,757	66,024
Kw.-hr. auxiliary	2,143,000	706,100
Output	30,093,000	10,385,900
Coal used, lb	29,886,000	9,722,000
Oil used, gal	2,570	0
Heat value of coal	10,354	10,886
Lb. coal per kw.-hr. generated	.927	.876
Lb. coal per kw.-hr. output	.993	.936
B.t.u. per kw.-hr. output	10,282	10,189
Thermal efficiency	33.18	33.49

Although some work remains to be done on this project to reach the goal set for it, it is gratifying to all concerned that after more than six months' commercial operation the unit is giving a good account of itself. Considering the number of difficult problems that confronted the equipment and project designers and the uncharted area they had to traverse, one can perhaps without exaggeration call this a bold achievement.

The high-pressure turbine bearing-vibration difficulty appears to be completely corrected. The carryover problem, while not entirely solved, is definitely within practical and easy control. Steam temperature or heating surface distribution and slag control are still awaiting complete solution, yet clearly appear to be on the road to such a state. With these exceptions, all other difficulties have been of such a minor nature as to be almost negligible.

Circulation, piping, pumping, valving and other difficulties failed to materialize. Difficulties with regard to steam generation or high-pressure turbine plugging predicted by those who had carelessly taken large doses of steam-solution theory also failed to materialize or have been put under operating control. The designers of the project and of the equipment concerned have every reason to believe that with their completion of boiler modifications the availability and performance of the unit will surpass design expectations.

It has been definitely proved that 2,500-psi. natural circulation boilers and 2,300-psi. steam turbines are technically sound and commercially workable.



EIGHTEEN HOURS to get 76,500-kw., 2,300-lb. compound turbine up to rated load

Washington Comment

By GEORGE E. DOYING, Jr., Washington Correspondent

REA Presses for an "In" on Defense

THE Rural Electrification Administration is growing out of short pants. It is looking beyond the simple realm of helping farmers group together for stringing distribution lines into their homes to the broader role of cooperative economic development in rural areas built around electric power.

The emergency may catapult this program into being in the Southwest. At worst, as REA views the situation, the defense program can only delay this evolutionary development.

REA has maneuvered into a potent bargaining position for the assignment of providing energy to the Defense Plant Corporation (RFC)-owned aluminum plant to be erected in Arkansas. Through one of its "holding-company" co-operatives, Western Oklahoma Power Co-operative, REA has a three-month start on delivery of six 7,500-kw. steam generators which could supply considerably more than one-third of the power for capacity operation of the aluminum plant. These generators were quietly ordered last July; installation could practically coincide with completion of the smelter.

Prepared to Lose, But—

These generators are the "leverage" in REA's determined campaign to get the job of providing power supply for the government plant. This six-unit central station offers the base energy for the plant's operation, the rest to be supplied by a utility-public hydro-REA pool during periods of capacity aluminum production.

But REA is prepared for the possibility that it may not get this job, that it may not even be permitted to take delivery on the generators. Priority authority of OPM and of the Supply Priorities and Allocations Board is sufficient to direct that the orders for the generators be transferred to some one else.

REA says it is ready and willing to surrender the generators if defense officials decide another course is a better one—but REA also takes the position, in effect, that "we found this idle manufacturing capacity and booked it; we ought to get some consideration for foresight."

Jesse Jones, in the last analysis, has the final say-so as to who is to provide the power for the aluminum plant. Mr. Jones says he has three alternatives: REA, private utilities or Aluminum Co. of America, which is to turn out the metal ingot. Mr. Jones says he will be guided to some extent by what OPM and the Army advise, in so far as any recommendations give full consideration to the two questions of speed in getting generators installed and of reliability of the power source. Long ago OPM Power Coordinator J. A. Krug and the Federal Power Commission jointly proposed a temporary pooling of public and private power reserves until a government-owned 90,000-kw. gas-fired station plant could be built.

If REA gets the nod, its Arkansas central station will become the biggest corner in a hydro-steam power pool in the Southwest put together by rural cooperatives, for the economic development of the rural area and its people. Already REA co-operatives have arranged to take the energy output of the Possum Kingdom and Grand River hydro projects. Other co-operatives formed by groups of co-operatives are building steam-generating stations at Minden, La., and in Upshur County, Texas, each with 10,000 kw. initial capacity.

Readying the Foundation

With the 45,000-kw. central station for aluminum, REA cooperatives would have a self-generation potential of upward of 75,000 kw. in an area comprising northern Louisiana, northeastern Texas and Arkansas. This is seen by these developers of the cooperative movement as a rock-firm base upon which to build a self-help economic "empire" to be operated for, by and of the rural folk in the area.

If REA's bid to be the aluminum power source doesn't materialize the rest of its program is still intact. Development will, admittedly, come harder and slower for the duration of the war. The important thing, as REA sees it, is that the development will come.

Already an REA cooperative is providing energy for a cinnabar mining development in Arkansas and others serve numerous other small business and industrial enterprises, building a power load beyond that of ordinary farm electricity.

Except as this development can be keyed to defense, there can be none during the war. This is REA's own idea of its situation. The whole of its energies are directed toward creating opportunities to grow within the defense program. There is no grass growing under the feet of its "promoter-salesmen" in seeking to take advantage of every opportunity.

If, As and When

Administrator Harry Slattery says that it has to be this way. In his recent editorial in the REA house organ, *Rural Electrification News*, he said that to the extent that copper and other materials are needed for defense, they will not be available for REA's normal line building.

When copper is available, he wrote in that editorial, REA will get it. He was talking about "civilian copper," and REA realizes that it may be a long time before civilian copper for ordinary line building is going to be available again. REA says it has accepted the SPAB dictum that construction work which cannot be tied to defense or to the health and safety of civilians must be deferred.

Which means that REA is continuing to do business only in the field of construction for which it can make out an acceptable case of defense tie-up. The only typical farm distribution lines which come within this category are those which will serve farmers producing dairy and

[*Continued on page* 172]

Editorials

S. B. WILLIAMS, *Editor*

Priorities Ban on Construction Must Be Fair

LONG OVERDUE was the order of SPAB banning new construction, public as well as private, which was not essential to national defense and to public health and safety. The order includes public works, flood control and power projects. However, if a project is under way and near completion efforts will be made to get the necessary materials to finish it.

From the standpoint of private construction this order amounts to little more than giving official recognition to a state of affairs already existing because of increasing difficulty in getting materials. What this construction veto really does is to give notice that it makes no difference whose money is involved. No government body, national or local, can have any critical materials unless it can prove need under national defense or public health and safety.

The real test of this order, however, will be its administration. A power project, for instance, may be suggested in the name of defense to serve a proposed aluminum plant. If power is available elsewhere, will the suggested project be allowed? A rural line may be proposed on the grounds that the farmers will then be able to use power in food production and processing. Will this be adjudged sufficient reason under the heading of defense for the project to go forward? Likewise, a transmission line to connect up several co-ops, now being served by private utilities, in order to take power from some government project? In the five-year power expansion program released this summer by FPC there were a great many federal hydro projects. Will these get a defense rating automatically?

All that we ask SPAB to do is to have the courage to apply the same critical test to government projects as to those of private companies. The order is fair, and if the administration of it is equally fair it should go a long way to inspire public confidence in our defense management.

Deflated Rates in an Inflated Market

EARLY IN September Secretary Morgenthau, speaking in Boston, said that we are now facing inflation, and to support his contention he drew a parallel between similar time intervals during the previous World War and this one. He showed how the purchasing power of the dollar between June, 1939, and June of this year had dropped 6 percent in living costs, with the dollar off 12 percent for food, 3 percent for clothing, 1 percent for shelter and 4 percent for heat and light.

Had the latter figure been broken down into its parts Mr. Morgenthau would have seen that inflation has not hit every element of living cost. Electricity, he would have discovered, cost less in June of this year than it did two years ago. Then it was approximately 4.07 cents per kilowatt-hour, this year but 3.79 cents. Thus, the June, 1941, electric light dollar instead of shrinking, like all other elements of living cost, was worth $1.074 in terms of the June, 1939, dollar.

Of course, this trend of electricity price against the general price tendency cannot continue. In fact, it is already slowing up, for rate decreases have not been nearly as numerous this year as last. Likewise, the automatic decrease that accompanies greater usage will be less and less in evidence as new load-building devices become scarcer. Also, adjustment clauses for fuel and taxes may be more common.

Neverthless, it might be good strategy to let the public know how non-inflationary the electricity dollar has remained and perhaps intimate that it cannot be expected to remain so forever, when everything else is shooting upward in price.

An Un-American Agreement

IN A RECENT AGREEMENT submitted by the Bonneville Administrator to a neighboring utility there was an article requiring the company to agree to make no expenditures to oppose a public power agency or to influence voters in a municipal ownership election or to help others in such opposition or to permit its employees to do so during working hours.

What has this country degenerated into when a government agency can obligate a company to give up its rights of self-protection? When Bonneville and other government projects were under construction they purchased power from utilities. What would have happened had these same utilities insisted on agreements whereby the project administrators were to refrain from competition with the supply companies?

Can you imagine a person, preliminary to the purchase of a piece of jewelry, signing an agreement not to molest or help to molest or to permit his servants to molest the jeweler if the jeweler should enter that person's home and take what he wanted? What's the difference?

If this un-American practice is typical of the Bonneville contractual operations, then the people of the North-

west, whether they take Bonneville power or not, had better pause to consider what will happen to their political independence if the Authority gets any stronger.

Bring Up the Evidence

INEVITABLE SHORTAGES of many more materials is in prospect as the defense program is intensified. Priorities will work up to a certain point and then outright allocations may be the easy escape of the administrative bureaus. By that time it will be tougher yet to establish one's claim to necessary materials and products. If utilities fail to get what they require imperatively it will be largely because they fail to make their case undeniably convincing.

Making a case convincing is largely a matter of persuasive statistics, and in the electrical field these must be in simple terms, because all too few people in authority understand electricity at all and little about what it takes to deliver it. Power factor and voltage correction by capacitors will always be an enigma to many. So why does aluminum foil for capacitors rate a high priority? The answer is to explain it in terms of more aluminum for planes. Every pound of aluminum foil in a capacitor employed to raise circuit efficiency can avert the necessity for perhaps 80 pounds of copper in distribution transformers and circuit load carrying ability. That released poundage can provide a system capable of making several pounds of aluminum every day.

Meters provide another example. Washington suggested that the problem of aluminum, copper and iron for watt-hour meters could be neatly solved in one fell swoop by going to flat charge forms of rate. The proposer was sounding what an occasional executive suggests as he looks at the "unproductive expense" of meter testing and reading. Both would admit that the meter is the cash register for the industry, but grope dimly for a less exacting alternative. Recent analyses by the meter committees give a convincing answer. They take public housing consumption experience as support for the statement that if the same wasteful use of energy as exists under the flat rate were to have applied to the 2,000,000 services for which meters were required this year the distribution capacities would have had to be increased by 15,000 to 30,000 tons of copper. Instead, meters were used taking but 1,000 tons of copper.

No Signs of Approaching Senility

SOMETIMES in the enthusiasm for the new we lose sight of the old, only to wake up to find that the old has been forging ahead steadily and statistically, at least showing no indication of being on the way out. Such is the case at the present time in the field of lighting. For more than three years fluorescent lighting has held the center of interest and percentage-wise its growth has been nothing short of phenomenal. Starting from scratch in the spring of 1938, a production of between twenty and thirty million tubes this year is evidence of something more than just talk.

In the meantime filament lighting, though short of its former glamor, has also been going steadily ahead. This year, according to the report of the I.E.S. lighting progress committee, the production of large lamps (including fluorescent) should reach 690 million—an increase of 95 million over 1940 and 156 million (30 percent) over 1939. Thus, fluorescent sales not only represent but 4 percent of the total large lamp demand, but the increase in filament lighting is nearly four to one over that of its rival.

In all likelihood filament lighting will give way eventually to fluorescent, but there are no signs of senility yet.

Familiarity Breeds Content

THE IMPORTANCE of having operating employees thoroughly familiar with their jobs and with the equipment and circuits they manipulate cannot be overestimated in these times. Reliability of facilities, of men and of service is paramount. Anything that can be done by instruction booklets, drawings, field trips, training of operators during erection periods will not only give greater confidence to the key men in emergencies but give assurance to those who have to rely on their actions.

In one recently built power plant practically the whole operating crew was assembled considerably before the plant was ready to operate. They saw the equipment assembled and installed, they saw the manufacturer's working drawings and instruction, they saw their installers make the working adjustments—in fact, they saw many things later hidden from their ken and observation. They had informal get-togethers every day to exchange knowledge gleaned this way.

With established plants and systems there is equal occasion to permit operators to learn first-hand about the equipment they administer by remote control at their boards. They and the company can profit by periodic opportunities to translate mere system diagrams into the physical realities of steel, wood, copper, aluminum, switches and banks, separations and clearances. They get to know the men for whom they place protective tags and pass switching orders. They sense their flesh-and-blood responsibilities in a humanized way.

On certain systems, for example, operators are systematically assigned to make these field journeys, and it does not have to be a big job to yield interest and profitable acquaintance with outside conditions. A changeover between lines serving particular districts, the provision of a new relay feed to a load center, installation of a unit transformer substation or the modernization of any outside electrical work provide excellent objectives.

To some this may seem like an overrefinement in training, but if it actually works to minimize serious trouble and to decrease the time of outage it should be worth something, at least in these times.

NEWS OF THE WEEK

A.I.E.E. Southwest Group Convenes in St. Louis

Power-rationing possibilities, post-war problems and technical sessions are features of meeting attended by more than five hundred delegates — Thirty-one papers presented

"The utility industry, and particularly those units faced with possible power curtailment, should begin now to prepare for rationing," Edward T. Gushee, executive vice-president of the Union Electric Company of Missouri, told delegates to the Southwest district meeting of the A.I.E.E. in St. Louis last week.

Pointing to the close relationship between civilian morale and continuous electric service, Mr. Gushee urged that "if rationing comes to any community . . . the reasons should be made clear to the public by both the utility and the proper government department." Any shortages in power for national defense needs are not the fault of utilities or of government officials, he said, but arise from an honest lack of conception of the size of the defense effort.

Post-War Problems

D. C. Prince, national president of the A.I.E.E., expressed the belief that under the impetus of defense activity national income can achieve $110,000,000,000 by 1943. Having attained this level, the opportunity exists, he said, to sustain it in the post-war period and secure for this country the highest standard of living yet reached. Whether this can be done successfully, Mr. Prince declared, depends largely on the ability of engineers to find and put forward the kind of industries that can put all the people to work and keep them busy.

In the technical sessions of the meeting the more than 500 delegates from Missouri, Kansas, Arkansas, Oklahoma, Texas and New Mexico heard 31 papers presented dealing with motors, electrical instruments, electrical machinery and power generation, transmission and distribution and related subjects.

P. O. Bobo, Oklahoma Gas & Electric, described a new relay for oil circuit breaker control, the salient feature of which is its ability to reset following successful reclosures, and after the breaker has remained closed a definite time as assurance that the fault is not permanent. Discusser H. T. Seeley (G.E.) found the increase in the percentage of successful reclosures with high-speed protective relays, as compared with normal-speed relays, evidence of the beneficial effect of reduction in arcing time on wires and insulators. W. A. Wolfe, Kansas Gas & Electric, praised the relay's elimination of the "blind spot" between last reclosure and next trip-out and commended the flexibility and adjustability of the timing element.

Five advantages of symmetrical nomenclature over standard for three-phase circuits were listed by Bryce Brady, Oklahoma Gas & Electric, in recommending its adoption. They were: (1) ease of use; (2) identifies single-phase fault currents; (3) describes all possible kinds of three-phase voltage displacement that can be created by delta-wye connections; (4) it can be applied

A.I.E.E. AT ST. LOUIS—Dr. William McClellan, president Union Electric Co. of Missouri, presided at A.I.E.E. convention luncheon last week at St. Louis. At head table were (left to right) Dr. McClellan, D. C. Prince, president A.I.E.E. and speaker at luncheon; H. H. Henline, national secretary, A.I.E.E., L. L. Crump, James R. Kearney Corp., and G. A. Waters, Wagner Electric Co., convention chairman

to all types of transformer connections, and (5) it is symmetrical and has resulting mathematical advantages.

R. H. Jones, Moloney Electric Co., developed explicit formulas for calculating transient and final temperature rise for oil-immersed, self-cooled transformers in the load range between two-thirds and double rated values of final oil rise above ambient, and final winding rise above oil. V. M. Montsinger (G.E.) in discussion found that the Jones formula should give more accurate results than the standard formula where the total body of oil is heated up to the same temperature.

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Jersey Utility Will Fight SEC Ruling

Public Service Corp. of New Jersey announced this week that it would challenge the Securities and Exchange Commission in the courts over a recent SEC decision holding the Jersey utility to be a subsidiary of the United Corporation and the United Gas Improvement Co.

On September 15 the SEC denied Public Service's application for exemption from the provisions of the Public Utility Holding Company Act by declaring that the corporation had not succeeded in proving that it was not controlled by U.G.I. or the United Corp.

Public Service's decision to start action was contained in a statement issued after a meeting of the board of directors this week. "The board adopted a resolution," according to the statement, "that the law department and officers appeal from the recent decision of the SEC which declared Public Service Corp. to be a subsidiary of U.G.I. and the United Corp. The appeal will be filed with the United States Circuit Court of Appeals in the Third Judicial Circuit in Philadelphia."

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OPM Schedules Conference for Electrical Men

OPM has scheduled a special one-day training conference for electrical manufacturers Friday, October 31, at the auditorium of the Chamber of Commerce of the United States in Washington, D. C. The meeting was requested by NEMA to enable those who are attending the NEMA annual meeting in New York to combine both events with a minimum of time and travel expense.

OPM will provide the speakers from the OPM staff and the talks will cover all phases of the priorities system.

Priorities Control Will Halt Non-Essential Work

SPAB decision expected to affect government, rivers and harbors, flood control and power projects, utility, commercial and residential building

The Supply Priorities and Allocations Board declaration that all construction, public and private alike, which cannot be shown to be essential to defense or civilian health and safety must be shelved for the duration is an assertion of authority. Under SPAB's charter from the President the agency can make its ruling stick, through control of priorities.

Specifically listed as construction which must meet the defense or essential civilian test or not be started are all government projects, rivers and harbors projects, flood control and power projects, utility, commercial and residential building. Rural electrification also comes within the scope encompassed by SPAB's announcement.

SPAB seeks to enlist federal, state and local governments behind its program, asking them not to issue permits or other authorizations for construction work for which priorities would have to be denied. Implicit, although not actually stated, however, is SPAB's assertion of the final right of say-so, through priorities, of whether almost any conceivable kind of construction project shall be undertaken.

No Utility Change

To private utilities SPAB's policies probably means little real change, because such construction already needed the assistance of priorities for completion, and this aid is not extended if OPM Power Coordinator J. A. Krug is not satisfied the work proposed is necessary. Project ratings will remain the avenue of approach for utilities seeking to undertake construction.

To REA the policy upsets the program outlined last summer by the then existing OPACS which proposed to allot materials to continue line building activities at one-half normal pace. REA's construction activities will not be halted, because those of its lines which are designed to serve farmers producing foods for the Department of Agriculture's "food-will-win-the-war" program, will pass muster under the defense test. Eligibility will be determined by individual projects, however, it is expected.

To public power development the policy probably will not be a brake. SPAB's attitude, like that of Coordinator Krug and the Federal Power Commission, is that all the capacity which can be manufactured will be required. What SPAB does is assert its right to the final say-so as to which projects are best fitted to meet defense requirements, just as it does with private utility construction.

Of particular interest to utilities is SPAB's urging, as a part of its construction policy, of greater emphasis upon substitution and use of less than usual amounts of critical materials in building work. Pointed suggestion is made that building codes in many cities require the use of excessive amounts of critical materials, and that such codes should be suspended for the duration.

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Dynamiter Barred from New Trial

Without a dissenting vote, the Michigan Supreme Court has brushed aside a legalistic bar to retrial of Monroe Causley on charges of conspiracy to dynamite power poles and wires of Consumers Power Co. during a strike in September of 1939.

Causley had sought a court order to compel Judge Herman Dehnke in Iosco County Circuit Court to dismiss the charge on grounds it provided felony punishment for conspiracy to commit an offense which was punishable as a misdemeanor.

The high court quoted laws going back to the Middle Ages in declaring such a situation was not improper, and commented that since a jury disagreed in Causley's first trial, the Legislature has made sabotage of utilities' services a felony.

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Lansing Purchases Boiler

The Board of Water and Electric Light Commissioners, Lansing, Mich., has purchased a boiler for the new addition to the Ottawa Street power plant. The boiler, similar to the two boilers now in the plant, will have a capacity of 300,000 lb. of steam per hour and will burn powdered fuel. It is being purchased from the Babcock & Wilcox Co. Approximate cost of the boiler and auxiliary equipment is $568,000. Delivery is promised in May, 1943.

New England Rationing Postponed by Rainfall

Boston conference held by Federal Power Commission to insure defense power for 1943 and subsequent years — Olds sees need for 330,000 kw. in New England

"Hydro-electric energy supply in northern New England has been strengthened by the rains of the past week to a point where power rationing can be avoided for about a month and even longer if further precipitation arrives in time," declared Chairman Leland Olds of the Federal Power Commission at a public utility conference in Boston, October 11, which was attended by state commission representatives, executives and operating officials from all parts of the northeast. The gathering was not open to the press, but at the conclusion of the opening session Chairman Olds and Thomas R. Tate, director of the board's defense power section, informally discussed the proceedings, stating that the objective of the conference was to insure adequate energy supply for the defense program, looking to 1943 and beyond. Mr. Olds said that all the utilities represented are fully co-operating with the commission in this objective.

Maine May Receive Aid

Plans are being considered for the construction of transmission lines into Maine from adjoining states to augment the supply of energy in the event of further protracted droughts. The Fernald law prohibits export of hydro-electric energy from Maine, having been on the statute books for many years, but importation of energy into the Pine Tree State would be legal, and through suitable interconnections the steam and hydro systems of central and southern New England can be made available to supplement existing facilities in the north. Temporary power rationing was required on the Bangor Hydro-Electric and Central Maine Power systems at the height of the drought. Construction is being rushed on additional steam-generating facilities by the latter system and enlarged storage capacity is in progress on the former.

Chairman Olds said that by 1943 about 330,000 kw. should be added to the New England systems over and above present programs to meet the requirements of the defense load, besides 30,000 kw. needed in Maine. Recent rationing was largely confined to industrial plants which have been purchasing surplus energy. He asserted that hydro-electric projects planned and under way in part by U. S. Army engineers on the Merrimac and Connecticut Rivers will be valuable in the defense program. This is expanding so fast that manufacturers of electric-generating equipment must turn out every possible kilowatt in capacity to meet the situation, and it is expected by the commission that it will take until 1945 to reach the maximum defense load. The present situation, while critical, has not been declared an emergency, Chairman Olds stated.

Atlanta Meeting

Leland Olds, chairman Federal Power Commission, discussed possible power curtailment with commissioners and power executives of the southeastern area Tuesday in Atlanta in an attempt to guarantee to those industries engaged in national defense work an uninterrupted supply of electric power.

Walter McDonald, chairman of the southeastern group of Association of Public Utilities Commissioners, announced the formation of a committee consisting of one power commissioner and one technical adviser from each of the following states—Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, Tennessee and Arkansas—to cooperate with FPC in arriving at fair and equitable conclusions. More effective pooling or mobilization of power supply among the various systems interested was suggested as a way in which curtailment might be deferred.

It was agreed at the conference that FPC should proceed at once to make the necessary preparations to initiate curtailment beginning November 3.

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Certified Repairs For New Orleans

In keeping with defense activities in business of all kinds, many electrical appliance dealers, in cooperation with the New Orleans Public Service, Inc., have established "Certified Electric Appliance Repair Shops" in neighborhoods throughout the city, it was announced recently by S. L. Drumm, general sales manager of the company.

"With necessary defense priorities creating new civilian shortages every day, it was thought that through this activity many work-saving, comfort-giving devices would be given new and longer life. This would at the same time afford the many needed materials generally used in the manufacture of electrical appliances to be converted to defense projects," Mr. Drumm explained.

"The places where this repair work will be done are designated by a red and yellow sign reading "Certified Electric Appliance Repair Shop." This sign guarantees efficient workmanship, reasonable prices, high-grade parts, courteous treatment and swift service. Whether it's only a minor adjustment or a general overhauling, these shops will be equipped to do the job," Mr. Drumm said.

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Bond & Share Hints Increases in Rates

Operating affiliates of Electric Bond & Share Co. are considering upward adjustments in rates, C. E. Groesbeck, chairman of the board of Bond & Share, stated at the annual meeting in New York last week. "No company has made an application for an increase in rates," he said, "but I know the companies have it in mind and are figuring on it." Other companies outside the Bond & Share group are also considering the matter, Mr. Groesbeck said.

It is understood that it has been the company policy for some time to suggest flexible rate clauses in rate schedules to take care automatically of increases or decreases in the costs of rendering service, which clauses obviate the necessity for formal rate cases and hearings.

S. W. Murphy, president of Electric Bond & Share, told stockholders that, as a result of defense activities, sales of electric service are up 14 percent and gas sales are running 9 percent ahead of last year.

"However, revenue from these and other services has increased only 7 percent," he pointed out, "reflecting increased use at low industrial rates. Higher operating expenses and greatly increased taxes have more than offset the increased revenues, and as a result net operating revenues are 4 percent lower than they were a year ago."

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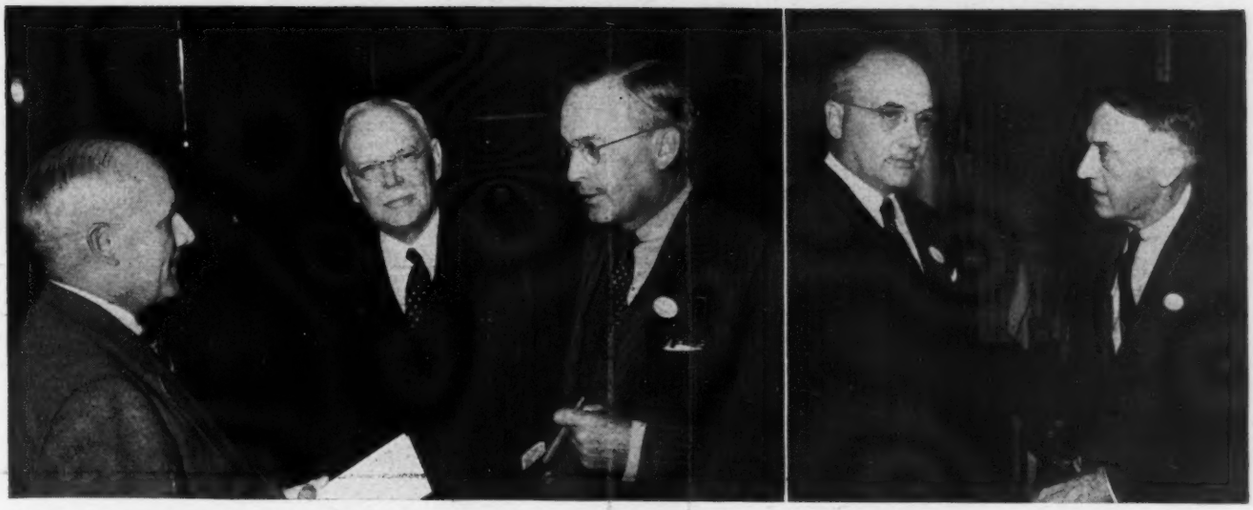
Closes Coulee Highway

To safeguard Grand Coulee Dam, the highway soon to be completed on the 4,300-ft. crest of the structure will not be opened to public traffic until the end of the present national emergency, the Bureau of Reclamation has announced.



AT MILWAUKEE MEETING—In attendance at convention of Wisconsin Utilities convention this week were (l. to r.) W. F. Whitney, Public Service Commissioner of Wisconsin; President S. B. Way, Wisconsin Electric Power; Vice-President M. H. Frank, Wisconsin Power & Light Co.; Vice-President L. F. Seybold, Wisconsin Electric Power, and S. B. Sherman, executive vice-president of Wisconsin Gas & Electric

Sales, Priorities and Rates, Wisconsin Topics

Association speakers urge greater efficiency in operations, continued advertising and promotion to maintain employment and meet company obligations to customers and government

Effects of growing defense loads, decreasing appliance volume and the pressure of priorities upon plant expansion, advertising and promotional activities of utilities were critically examined by speakers representing regulatory bodies, utilities and electrical manufacturers at the electric section convention of the Wisconsin Utilities Association at Milwaukee this week. Through them the industry was encouraged to continue and augment its advertising and sales promotion efforts to hold past gains, maintain employment and meet service and tax obligations to the public and the government. Speakers urged improvement in operating efficiency to meet impending cost increases without disturbing the present status of rates.

W. F. Whitney, Commissioner Wisconsin Public Service Commission, urged unity of action between utilities and state commissions to increase the potential interchange of power between systems. The matter of increasing costs, Whitney declared, is serious. Utility rates are fixed, and cannot be instantaneously raised, the lag between prices and rate increases produces uncertainty and instability. "I hope," Commissioner Whitney asserted, "that the existing unsettled period can be weathered without disturbing the present status of utility rates."

C. E. Greenwood, Edison Electric Institute, emphasized the need for utilities to continue advertising and dealer promotion. "Load building must continue now and in the future," he declared, remarking that "there can be nothing unpatriotic in self-preservation." Greenwood expressed belief that J. A. Krug, power consultant of O.P.M., in asking recently that utilities curtail all promotion, "either did not have in mind strict cutting out of all selling, or he has not all the correct premises on which to arrive at that conclusion."

L. C. Blevins, Westinghouse meter sales manager, said that for the past six months meter manufacturers have known that unless meters are put on priority the time is not far off when they would have to stop making meters. Contrasted to electric instrument production, which is 85 percent on priority, less than 5 percent of this year's meter orders was on priority, he stated. Although he expressed belief that OPM Order P-46 gives a lease of life to meter production, the problem of getting meters without priority, he implied, is now largely out of manufacturers' hands and up to utilities.

C. M. Snyder, G. E. appliance merchandise division, said appliance volume next year would probably be cut back to 61 percent of 1941 production, or about the equivalent of 1939 production. He asked utilities to continue advertising, to get old appliances back on the lines, to continue promotion of the low-use customer and the dealer. He urged them to seek larger units of sale—such as entire electric kitchens—to encourage dealers to take on non-electric lines and look to the possibilities of service after sale.

New officers of the electric session for the coming year are: Chairman, Commercial Division, Paul De Leon, Wisconsin Power & Light; vice-chairman, J. P. Dunham, Wisconsin Gas & Electric. For the Technical Division, chairman, J. A. Tyvand, Wisconsin Gas & Electric; vice-chairman, Vincent Thiemann, Wisconsin Public Service.

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Indiana Municipal Units Take Concerted Action

In a move to meet problems created by priorities and national defense activities, representatives from municipally owned electrical plants throughout central Indiana have decided to form a corporation. The decision was reached at a meeting held recently at Tipton. Final arrangements and actual organization will be made at a meeting in Frankfort on October 29.

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Flat Rate in Indiana

For the first time in years electric and gas customers of a major Indiana city will be charged a flat utility rate. A flat charge of $6.55 a month will be added to the rents of families occupying the defense housing apartments being constructed in South Bend. Four-unit gas ranges and refrigerators of six-cubic-foot capacity will be in each of the apartments whether they are one, two or three bedrooms.

Glenville Hydro Plant Goes Into Operation

Highest hydro development in East at Glenville, N. C., has single 27,000-kw. Allis-Chalmers unit coupled to two 15,000-hp. A.-C. impulse wheels

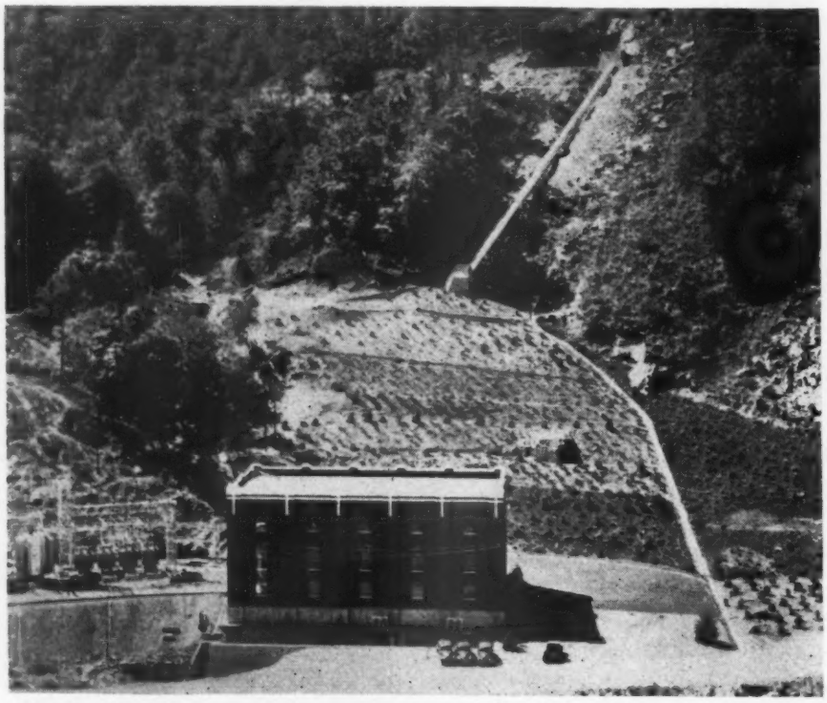
A new high-head, storage type hydro-electric plant, the Glenville plant, located near Glenville, in the western part of North Carolina, went on the line October 13 in aluminum production at Alcoa, Tenn. A companion plant, located at Nantahala, N. C., will follow on the line within a few months. These two plants will serve to firm up the capacity of two existing run-of-stream, hydro-electric plants previously built by the Aluminum Company of America and its subsidiaries along the Little Tennessee River. A third existing high-head storage type plant at Calderwood also serves a similar purpose.

At Glenville a single 27,000-kw. Allis-Chalmers unit is coupled to two Allis-Chalmers impulse wheels, each rated at 15,000 hp. The 1,215-ft. gross head at Glenville is the highest of all hydro developments in the East. The 60,000-hp. Francis reactor turbine at Nantahala will be the first reactor turbine application to such a high head (rated at 925 ft.).

The Cheoah plant, the first plant to be built on the Little Tennessee watershed, was completed in 1919 and comprised an initial installation of three 20,000-kva. units, and a fourth unit was installed in 1925. The plant is located on the Little Tennessee River just above the mouth of the Cheoah River and has an average operating head of 183 ft.

Santeetlah, the second development, was completed in 1928 and has a storage capacity of 134,000 acre-feet and a maximum operating head of 660 ft. The power house is located on the Cheoah Lake about 5 miles up stream from Cheoah Dam. The stored water is used through three plants, Santeetlah, Cheoah and Calderwood. Santeetlah Dam is located on the Cheoah River 10 miles above its mouth. A 5-mile pressure conduit carries the water from the dam to the power house through a series of five mountains. Two 25,000-kva. units are installed.

Calderwood development, located on the Little Tennessee River 9 miles below the Cheoah plant, was completed in 1930. Two 45,000-kva. units were installed initially and the third unit was added in 1938. This plant operates under an average head of 217 ft.



HIGHEST IN EAST—Maximum head on the double impulse horizontal turbine at Glenville, N. C. plant is 1,205 ft., highest in the Eastern United States. Plant went on the line October 13 and will serve to firm up capacity

Prime capacity of the three original plants and the two new plants will amount to 120,000 kw. There will be available varying amounts of secondary power up to a maximum of 180,000 kw.

Contracts have been in effect with the Tennessee Valley Authority since July 17, 1936. These contracts vary from 30,000 kw. prime power up to a maximum of 112,000 kw. when hydro-electric power is available. Supplementary contracts have been made covering steam-generated power whenever available.

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Kansas City Buys Boiler, Condenser

In order to keep ahead of national defense load demands, Kansas City Power & Light Co. has recently purchased a new boiler and a new condenser for the turbo-generator bought in June for installation at Grand Avenue.

An order for the boiler, rated at 300,000 lb. of steam per hour, was placed recently with Combustion Engineering Co. of New York. It will operate at 650 lb. pressure and at 950 deg. temperature, one of the highest yet to be used for this type boiler in the United States. The boiler will cost approximately $400,000 exclusive of other auxiliary equipment necessary.

The 32,500-sq.ft. condenser was purchased from Worthington Pump & Machinery Co., Harrison, N. J., at a cost of about $90,000.

According to J. A. Keeth, Northeast station, the program now under way calls for the new boiler to be installed and operating by December, 1942.

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Finish New Sunset Unit in Spokane

Washington Water Power Co.'s new Sunset substation, 29th Avenue and Hangman Creek, is now completely interconnected with the rest of the system, J. E. E. Royer, vice-president and general manager, recently announced.

The new substation, part of a project estimated to cost approximately $340,000, was begun in the spring of 1940 and provides a new source of electrical distribution. The final step in completing the project was the moving of transmission lines and main feeder lines from the 29th Avenue substation.

The Sunset station is served by two double-circuit 60,000-volt transmission lines from the Little Falls power plant and is connected with the company's East Side substation by an 8½-mile 60,000-volt line, built last year.

NEWS BRIEFS

POWER SALES ENGINEERS will be interested in a 44-page booklet issued by the American Hotel Association describing "Electric Current Consumption Costs and Savings." Breakdowns of usage, applications and operating characteristics of 468 hotels make this book a useful tool for the power sales department.

WISCONSIN PUBLIC SERVICE has just come out with a red, white and blue folder in which President J. P. Pulliam announces a payroll allotment plan by which any regular employee may purchase Defense Savings Bonds.

EIGHT MONTHS after ground was broken two Naval ordnance plants built and operated by Westinghouse for the Navy began production of gun mounts and other advanced equipment. A $20,000,000 plant at Canton, Ohio, will employ 2,000 people and the $11,000,000 ordnance plant at Louisville, Ky., will employ approximately 1,500.

"THE FRIENDLY PEOPLE" is a component of the Central Ohio Light & Power Company signature to its advertising. Two of the company's institutional advertisements which came across our desk personalized the company even further, as one advertisement carried the name of the manager and the other the name of a district representative.

MICHIGAN SECTION, A.I.E.E., has been invited by Gov. M. D. Van Wagoner to participate this month in the formation of a defense advisory committee. Scope of the work includes power networks, protection of power supplies and setting up emergency generating, transmission and distribution facilities.

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Rosenwald Heads New Conservation Board

OPM this week formally established its bureau of Industrial Conservation to head up all government efforts toward saving critical materials through substitution, simplification and standardization (ELECTRICAL WORLD, September 13, page 10). Lessing J. Rosenwald, former chairman of the board of Sears, Roebuck & Co., is chief of the new branch, a unit in OPM's division of purchases.

The bureau will direct its activities toward revision of government specifications, avoidance of waste in industrial practices, promotion of use of substitute materials, stimulation of the collection of salvage, simplification of service and manufactured goods, and general elimination of non-essential uses of materials in which shortages exist or may develop.

Most of the bureau's work will be carried on through OPM commodity branches—such as the Electrical Products Unit for appliances. It will cooperate in so far as possible with existing agencies in this field, including the recently formed Engineers' Defense Board, the consumer division of OPA, the Bureau of Standards and the federal specifications executive committee.

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Appeals Bluestone Case

West Virginia Power Co. and the Norfolk & Western Railway Co. on October 8 appealed a decision by the Fourth Federal Circuit Court upholding the position of the government in the Bluestone Dam case (ELECTRICAL WORLD, September 27, page 4). U. S. District Attorney L. R. Via has predicted that the appeal will be heard by the U. S. Supreme Court "within a month." He said that because of its importance the case probably would be given precedence on the docket, which includes some 650 other cases.

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Advertising Expenditures

A recent survey by the Public Utilities Advertising Association concerning 1940 advertising expenditures by various electric and gas utilities revealed that the average was $0.49 per customer, with individual utilities spending as much as $1.79 per customer and as little as $0.23 per customer. The survey covers 31 percent of the industry and the expenditures on the average were 0.67 percent of gross revenue.

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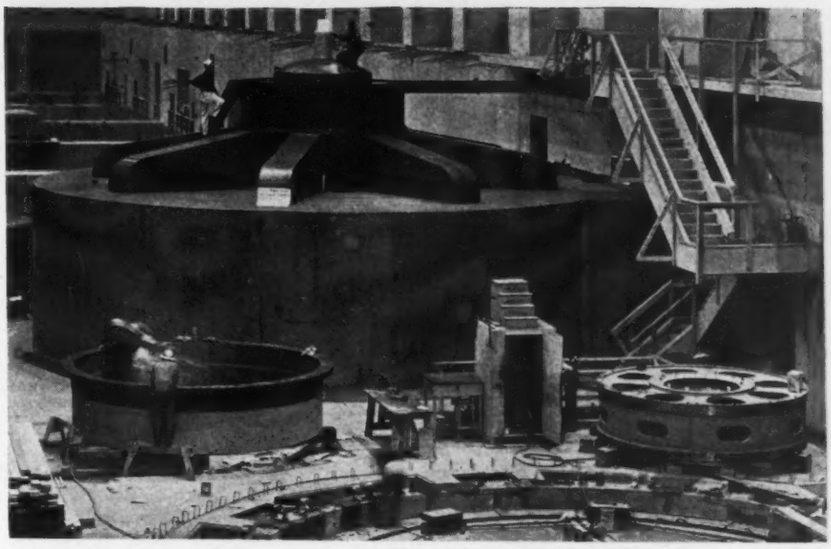

FIRST OF THREE—Grand Coulee's first 108,000-kw. generator, which went into regular service this month. A second unit is expected to go on the line in January and a third some time during 1942

Grand Coulee Starts Large Generator

The first of the 108,000-kw. generators at Grand Coulee Dam has gone into service and was connected October 4 to the 1,500-mile transmission network of the Bonneville Power Administration.

The new generator increases the power supply of the Department of Interior for defense and peace-time industry to a total of 356,400 kw., Bonneville Administrator Paul J. Raver said. "This means," he added, "that the government, through its Columbia River development, will be able to take care of the vastly increased defense industrial capacity planned for the Pacific Northwest during the next few months."

The new Grand Coulee generator is the first of eighteen to be ultimately installed in the two power houses at the base of the dam. A second large generator will be ready for operation some time in January, it was said, and a third generator is scheduled for operation in 1942.

Due to the intensified development of the electrometallurgical industry in the Pacific Northwest during the past few months the administrator has recommended that installation of fifteen of Grand Coulee's eighteen generators be expedited and that money be made available for their purchase.

Strike Developments Impend on Coast

Utility Workers Organizing Committee Local 134 (CIO) voted union negotiators authority to call a strike against Pacific Gas & Electric Co. when discussions relating to wage increases and recognition reached an impasse last week. The local represents workers in Alameda County on the east side of San Francisco Bay.

The dispute hinges on CIO charges that the company is fostering an independent union which won an overwhelming majority in a 1937 election as bargaining agent for P. G. & E. employees. Later the election was declared invalid by the NLRB because of CIO representations of company interference. However, the independent union had been recognized by company officials and wage and working condition contracts entered into between company and union.

Since then the AFL International Brotherhood of Electrical Workers, which did not take part in the 1937 election, has petitioned the NLRB for a new election. Its petition cited the same charges as the CIO, namely, "company interference and domination" of the independent union.

When NLRB efforts to mediate the latest outbreak failed, Sidney Hillman associate director of OPM, who was in San Francisco at the time, asserted that he would seek federal intervention because of the effects of power interruption on national defense projects.

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Dallas Power Seeks City Approval of Extension

Dallas Power & Light Co. has filed a new request with the City Council that it approve the company's plans for the expenditure for enlarging the power facilities of its generating plant at Mountain Creek Lake at a proposed cost of $2,260,000. This second request came immediately after the action of the city council disapproving the original request because it wanted more time to consider it.

"It may be of interest to know that electric customers in Dallas required in the month of September, 1941, approximately 22 percent more electrical energy than in September, 1940," President George L. MacGregor of the company said in the letter resubmitting the project.

Frank R. Schneider, municipal supervisor of the public utilities, said he has not been convinced fully that the requisition should be approved and one suggestion he has made is that the company should let the Texas Power & Light Co., an affiliated utility, install the equipment and later sell power to Dallas if it should be needed later.

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Alabama Power Extends Rural Service in 1941

During the first eight months of 1941, the Alabama Power Co. has extended electric service to 5,000 new rural customers. During the remainder of the year the company estimates that it will serve 2,500 additional rural customers, which will make a total of 7,500 new rural customers during the year. About 6,000 of these new customers are farms and the other 1,500 are rural residents, country stores, schools and churches.

This extension of electric service to rural customers is a continuation of the company's rural electrification program started in 1924.

Of the 48,000 rural customers to whom the company has extended the conveniences of electric service, 7,000 have been transferred to urban rates, 5,000 were served from lines that have been sold to TVA and others, and 36,000 are served at the company's rural rates.

MEETINGS

American Welding Society—Annual meeting in conjunction with National Metal Exposition, Bellevue Stratford Hotel, Philadelphia, Pa., October 19-24. Miss M. Kelly, secretary, 29 West 39th St., New York, N. Y.

Edison Electric Institute—Transmission and distribution committee, Netherland-Plaza Hotel, Cincinnati, Ohio, October 20-22. Col. H. S. Bennion, managing director, 420 Lexington Av., New York, N. Y.

Oklahoma Utilities Association—Eastern district conference, Muskogee, Okla., October 23; western district conference, Norman, Okla., October 24. Kate A. Niblack, secretary, 625-26 Biltmore Hotel, Oklahoma City, Okla.

National Electrical Manufacturers Association—Annual meeting, Waldorf-Astoria Hotel, New York, N. Y., October 27-31. W. J. Donald, managing director, 155 East 44th St., New York, N. Y.

National Research Council—Conference on Electrical Insulation, annual meeting, Williamsburg, Va., October 30-November 1. Thorstein Larsen, secretary, Consolidated Edison Co. of New York, 55 Johnson Street, Brooklyn, N. Y.

Southeastern Electric Exchange—Fall sales conference, Henry Grady Hotel, Atlanta, Ga., October 30-November 1. J. W. Talley, executive secretary, 303 Haas-Howell Building, Atlanta, Ga.

International Association of Electrical Leagues—Sixth annual conference, Raleigh Hotel, Washington, D. C., November 12-14. O. C. Small, secretary, 155 East 44th St., New York, N. Y.

American Society of Agricultural Engineers—Fall meeting, Stevens Hotel, Chicago, Ill., December 1-3. Raymond Olney, secretary, St. Joseph, Mich.

Exposition of Chemical Industries—Grand Central Palace, New York, N. Y., December 1-6.

American Institute of Electrical Engineers—Southern district, St. Charles Hotel, New Orleans, La., December 3-5; winter convention, New York, N. Y., January 26-30. H. H. Henline, national secretary, 29 West 39th St., New York, N. Y.

National Association of Manufacturers—Congress of American Industry, Waldorf-Astoria Hotel, New York, N. Y., December 3-5.

War Department Aids Washer Industry

The entire household washer and ironer manufacturing industry has been certified to the War Department by the Office of Production Management for special treatment on defense business to alleviate growing curtailment of normal output. It marks the first time an entire industry has been recommended to the military branch for defense contracts; previously certification has been by communities.

The washer-ironer recommendation originated in Floyd Odlum's Division of Contract Distribution, the result of a detailed industry study by a committee of engineers to determine what war products could be turned out with relatively little changeover from existing assembly line setup. (ELECTRICAL WORLD, August 16, page 6.) The survey disclosed that seventeen different items could be produced alongside washers and ironers by the industry, the items ranging from anti-aircraft machine gun mounts to bomb fin assemblies.

A substantial order for any one of these items would absorb the bulk of the 632,000 of monthly man-hours of unemployment estimated as resulting from production curtailment within the industry, D.C.D.'s certification states. Three of the leading manufacturers—Nineteen Hundred Corp., Apex Electrical Manufacturing Co. and Easy Washing Machine Corp.—have been selected by D.C.D. and the industry to receive prime contracts from the War Department. These concerns, in turn, will sub-contract portions of their defense contracts with the 31 other manufacturers in the field in accordance with the amount of curtailment each faces.

•

P.G. & E. Defends Record in Newspaper Ads

Taking the issue of Plan 9 ($66,500,000 Hetch Hetchy power bond campaign designed to put San Francisco in the municipal power business by purchase of parts of Pacific Gas & Electric Co.'s distribution system) directly and squarely to the citizens of that city by paid newspaper advertisements, Pacific Gas & Electric Co., under the signature of James B. Black, president of the company, vigorously defends its record of service and argues the alleged savings to be effected by Plan 9. In each advertisement there appears the notice that the space was paid for out of surplus and is not a charge against rates.

Output Continues to New Fall Peaks

Output of electrical energy distributed by the electric light and power industry for the week ended Saturday, October 11, established a new all-time peak with a total of 3,314,952,000 kw.-hr., according to the Edison Electric Institute.

The present normal rate of increase continued this week as output mounted 17.7 percent above the corresponding week a year ago.

A year ago output was increasing over the 1939 output at the much lower magnitude of 9.4 percent.

New England assumed the lead this week with a gain of 20.7 percent, followed by the Rocky Mountain area with a gain of 20.3 percent.

Similarly large gains were recorded by Central Industrial—19.6 percent ahead of last year, and by the Southern States showing a 19.3 percent gain.

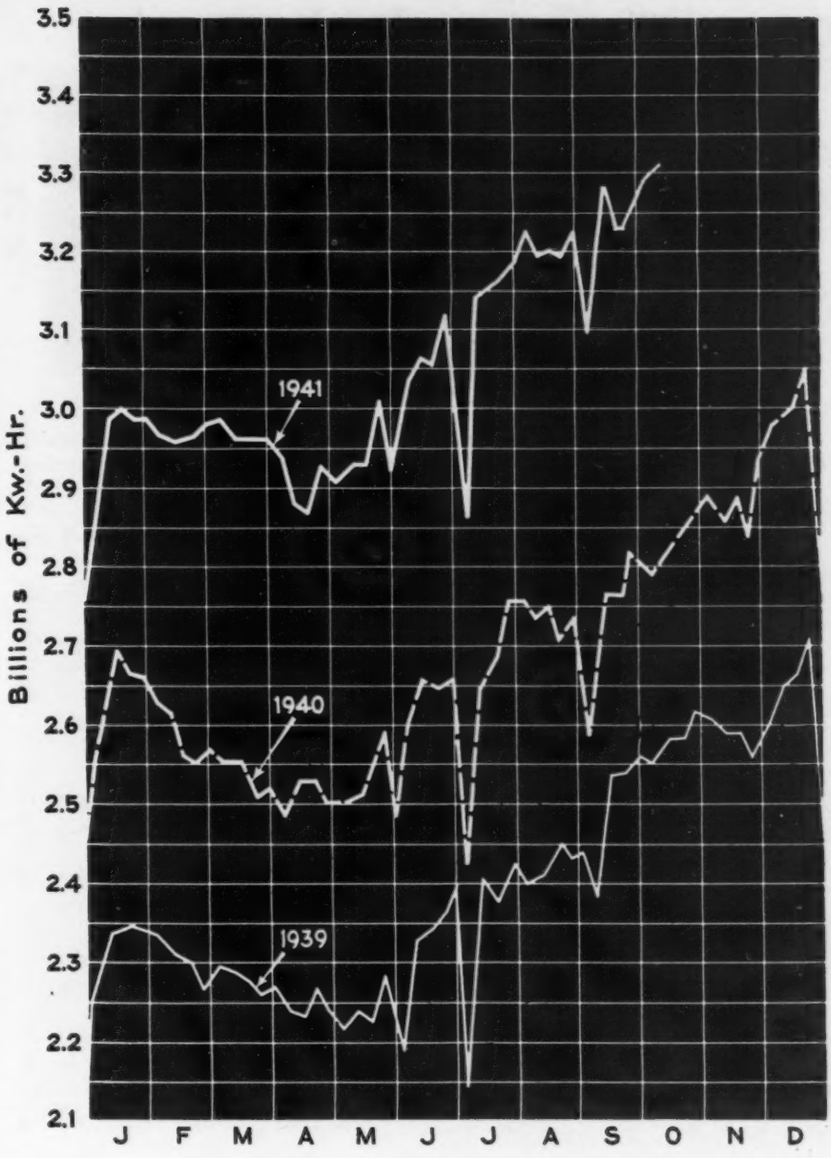
Weekly Output, Millions Kw.-Hr.

1941		1940		1939	
Oct. 11	3,315	Oct. 12	2,817	Oct. 14	2,583
Oct. 4	3,290	Oct. 5	2,792	Oct. 7	2,554
Sept. 27	3,233	Sept. 28	2,816	Sept. 30	2,558
Sept. 20	3,232	Sept. 21	2,769	Sept. 23	2,538
Sept. 13	3,281	Sept. 14	2,773	Sept. 16	2,532
Sept. 6	3,096	Sept. 7	2,592	Sept. 9	2,376

Percent Change from Previous Year

	Week Ending		
	Oct. 11	Oct. 4	Sept. 27
New England	+20.7	+19.9	+18.9
Mid-Atlantic	+16.3	+14.8	+10.8
Central Industrial	+19.6	+20.7	+17.4
West Central	+15.7	+16.8	+13.1
Southern States	+19.3	+20.2	+16.8
Rocky Mountain	+20.3	+19.1	+17.1
Pacific Coast	*+10.6	*+10.4	*+ 9.6
Total United States	*+17.7	+17.8	+14.8

* Percentage should be higher — data under revision.



100,000-Kw. Kentucky Plant Progressing

Plans for the proposed new steam power generating plant of the Kentucky Utilities Co., to be erected on the bank of the Kentucky River at Tyrone, Ky., 4 miles from Lawrenceburg, Ky., are progressing.

Workmen are now grading the site of the station, trackage to be laid in, and for highways. The first unit will be 25,000 kw., with foundations poured for a second unit of 25,000 kw., and plans for foundations to be eventually laid for two additional units of the same size, to provide 100,000 kw. in all and make it one of the largest generating stations in the South.

R. M. Watt, president Kentucky Utilities Co., reported contracts had been let for equipment, but that construction of buildings would be held up pending assurance from equipment manufacturers that contracts could be filled on schedule. Due to national-defense priorities, electric generating equipment is not available for private corporations until release has been approved by federal officials. However, the Tyrone project is being installed to augment the supply of available electricity to the national defense plants in Southern territory.

•

Issue Yardstick on Costs

The Federal Power Commission has published its first statistical yardstick of electric utility costs, containing analyses of those costs based on a study begun in 1938 of 393 large companies comprising, on the basis of assets or revenues, more than 95 percent of the nation's privately owned electric light and power industry.

Sharp Advance Reported in Appliance Sales

Sales of major appliances by cooperating dealers of the Virginia Public Service Co. for the first seven months of 1941 showed an amazing increase over the same period of the previous year. Unit sales are as follows:

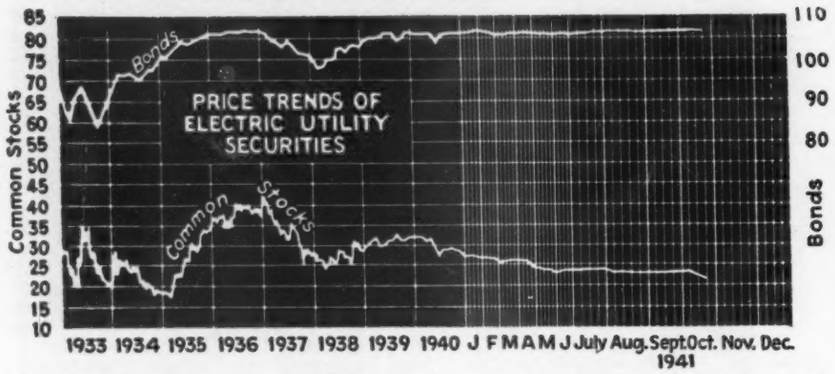
	Seven months 1941	Through July 1940
Ranges	1,177	1,055
Refrigerators	10,255	9,215
Water heaters	537	372
Miscellaneous	4,878	3,019

•

Vote to Acquire Plant

Citizens of the small Ohio River town of Cannelton, Ind., have voted in a special election held recently for the purchase of the local power plant by the municipality from the Ohio River Power Co., a unit of Associated Gas & Electric System.

Utility Securities Turn Downward


PRICE TRENDS OF ELECTRIC UTILITY SECURITIES
Bonds
Common Stocks
Common Stocks
Bonds
85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10
110 100 90 80
1933 1934 1935 1936 1937 1938 1939 1940 J F M A M J July Aug. Sept. Oct. Nov. Dec.
1941

During the past week prices of electric light and power securities decreased slightly. "Electrical World" stock index dipped to 23.0 from 23.1 the preceding week; last year, 28.5. Bond index stood at 105.8; last week, 105.9; last year, 106.1

Associated to Sell Arkansas Property

The only Arkansas property of Associated System, Arkansas General Utilities Co., will be sold for $325,000 to Walton Sullivan Company, investment bankers in Arkansas.

Arkansas General Utilities Co. owns and operates electric, water and ice properties in the south central part of Arkansas. The electric facilities of the company are not interconnected with any other unit in the Associated System nor are they capable of such interconnection, it was said, so the sale therefore marks another step in the trustees' integration and reorganization program. The sale will provide additional cash for the needs of the Associated Electric Co. sub-holding group, in which both of the above-named companies are subsidiaries.

•

Direct Sale of Stock by Utility Protested

Representatives of fourteen Louisville brokerage companies protested at a Securities and Exchange Commission hearing this week in Washington, D. C., against the Louisville Gas & Electric Co.'s application for permission to sell 150,000 shares of common stock direct to the general public. They contended that the stock should be sold through dealers instead of by a utilities concern.

Charles W. Milner, of counsel for Louisville Gas, declared that the stock will be sold to all who wish to buy. He revealed that five employees of the company, one with securities-selling experience and four salesmen of electrical and gas appliances, will carry on the campaign to sell the shares.

Commissioner Healy asked Mr. Milner what ratio the company would use if subscriptions to the shares exceed the number being offered. "That has not been decided upon," Mr. Milner replied.

•

Philadelphia Utility Plans Financing

Horace P. Liversidge, president of the Philadelphia Electric Co., has called a special meeting of stockholders for December 12 to act on proposals to increase the authorized number of preferred and common shares.

"In the opinion of the board of directors, it is desirable that the company be in a position to provide at least a portion of its future capital requirements through the medium of stock financing," Mr. Liversidge wrote.

The letter also disclosed that the company plans to retire the 280,058 shares of $5 dividend preferred stock now outstanding by exchange or redemption.

Utility Reports

	Net Income 1941	1940
*Alabama Power	$3,583,551	$3,453,487
*Arkansas Power & Light	1,345,114	1,156,119
*Consumers Power	11,129,893	10,863,983
†Duquesne Light	10,395,242	10,423,563
*Florida Power & Light	2,688,452	2,332,719
*Georgia Power	5,321,519	4,238,766
*Gulf States Utilities	2,219,717	2,645,104
*Idaho Power	1,453,272	1,519,075
*Kansas Gas & Electric	1,587,975	1,370,669
*Louisiana Power & Light	1,104,683	1,061,491
*National Power & Light and subs.	8,600,879	8,694,782
*Ohio Edison	4,327,555	4,193,525
*Utah Power & Light and subs.	1,925,039	1,774,157
*Virginia Electric & Pwr.	4,214,357	4,081,310

*Twelve months ended August 31.
†Twelve months ended July 31.

Milwaukee Sues Board on Financing Order

Suit has been filed in the Circuit Court at Madison, Wis., by the city of Milwaukee to force the Wisconsin Public Service Commission to vacate a July 22 order and a refusal for a rehearing on August 9, covering a financing of the Wisconsin Electric Power Co.

The city charges that the commission authorized the company to issue 1,265,000 shares of common stock at $10 a share in exchange for the purchase of $6,000,000 worth of stock of the Wisconsin Gas & Electric Co. and $6,000,000 worth of stock of the Wisconsin Michigan Power Co.

The commission also authorized the Wisconsin Electric Power Co. to transfer $3,300,000 from its depreciation reserve to a reserve for contingent losses on its investment in the Milwaukee Electric Railway & Transport Co., the city charges, assessing the city and its residents at an excessive rate for electric power for the purpose of covering losses of another district utility. The city contends the transfer was unlawful.

•

Tacoma to Enlarge Unit at Cost of $625,000

Tacoma Department of Public Utilities, Tacoma, Wash., has been authorized by City Council to enlarge the Tide Flats substation at a cost of $625,000 by installing additional transformer banks, condensers complete with circuit breakers, switches, steel structures, switchboards and control wiring and extending switchboard and control building. The Board of Contracts and Awards has been authorized to call bids.

The board has also been authorized to purchase cable, network protectors, transformers and miscellaneous equipment required for the installation of an additional feeder in the underground electric distribution system at an estimated cost of $20,000.

•

Authorizes New Lines

Illinois Commerce Commission has issued certificates to four utilities companies authorizing construction and operation of 23.62 miles of rural electric line in White, Calhoun, Lawrence, Marshall, Livingston, Kankakee, Madison and Winnebago counties. The companies and the number of miles of line each will build are: Central Illinois Public Service, 2.97; Public Service Co. of Northern Illinois, 10.25; Union Electric Co. of Illinois, 2; South Beloit Water, Gas & Electric Co., 8.4.

CALL ON THESE "RED CAPS"

To Give Metropolitan Service on Your Rural Lines

FP-119 Reclosers on the Assembly Line

YOU'LL save money—and take a load off your mind as well—by installing FP-119 circuit reclosers on your rural lines. Scores of operators, from Canada to tropical Puerto Rico, have done so. They find that these reclosers provide continued service through as many as 90 per cent of their line faults.

FP-119 reclosers, they report, give real service!—by automatically restoring power immediately after interrupting the circuit to clear transitory faults. Recently, during a severe electrical storm in South Carolina, one of these reclosers cleared *16 line faults* during a single night—and promptly restored service every time!

136 LINE FAULTS—*only three sustained outages*

And from Rushville, Ind., A. M. Miller of the Southeastern Indiana Power Company writes, "Results were so gratifying that we purchased three more FP-119's. We now have a three-month record and it reveals that we have had 136 operations in this period. Three of these were lockouts caused by limbs falling over the lines. On the remaining 133 we never knew when a fault occurred, as we had no outages at all."

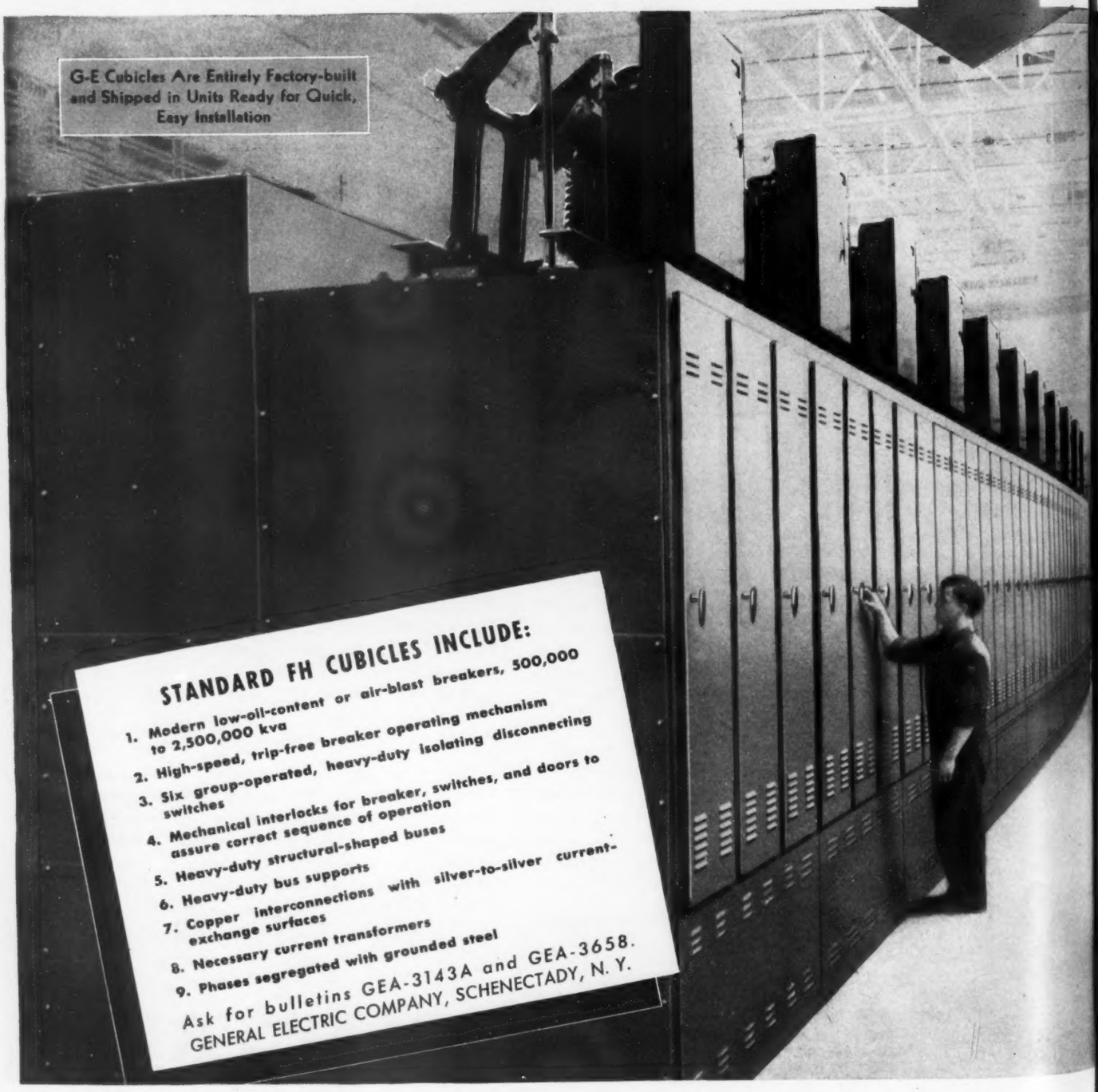
Performance like this has caused the demand for FP-119 reclosers. And this increasing demand, together with standardization and efficient production-line assembly methods, has, in turn, made possible still another reduction in price—to $99! Why not take advantage of this new low price, now? If you'd like more detailed information, just ask for Bulletin GEA-2846A. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

857-4-7400

This Is THE SWITCHGEAR

FH CUBICLES with OIL-BLAST BREAKERS


G-E Cubicles Are Entirely Factory-built and Shipped in Units Ready for Quick, Easy Installation
STANDARD FH CUBICLES INCLUDE:
1. Modern low-oil-content or air-blast breakers, 500,000 to 2,500,000 kva
2. High-speed, trip-free breaker operating mechanism
3. Six group-operated, heavy-duty isolating disconnecting switches
4. Mechanical interlocks for breaker, switches, and doors to assure correct sequence of operation
5. Heavy-duty structural-shaped buses
6. Heavy-duty bus supports
7. Copper interconnections with silver-to-silver current-exchange surfaces
8. Necessary current transformers
9. Phases segregated with grounded steel
Ask for bulletins GEA-3143A and GEA-3658.
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

for ANY POWER STATION

FH CUBICLES with AIR-BLAST BREAKERS

Compact, Segregated-phase Switchgear—a Complete Installation in Itself

FOR POWER-STATION SERVICE up to 23,000 Volts and 2,500,000 Kva

GENERAL ELECTRIC

OPERATING PRACTICES

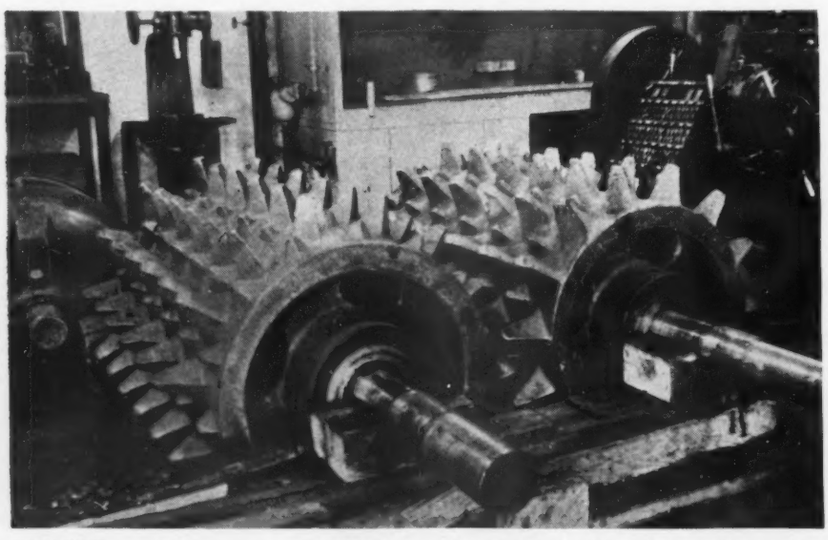
Arc Welding Builds Up Crusher Rolls

Hard surfacing with the electric arc process avoided the replacement of a set of coal crusher rolls which are made of manganese steel and are 4½ ft. long by 30 in. in diameter. The rolls are located in the Williamsport, Md., power station of the Potomac Edison Company and are employed in connection with four overfeed stokers serving four boilers with a combined steam output of approximately 700,000 lb. per hour.

With welding, it is a simple matter to restore the one inch of metal which in time wears off each tooth, and which, otherwise would necessitate replacement of the whole roll. The weld metal applied by the electric arc makes the teeth as good as new at a small fraction of the cost of new rolls.

This is the second time this set of rolls has been built up by welding, and according to F. J. Brimmer, assistant plant superintendent of the Williamsport station, unlimited savings are permitted because welding enables the part to be built up innumerable times. He also considers it significant that this equipment can be repaired by welding much sooner than new rolls could be secured.

The welding was done with "Manganweld" electrodes supplied by the Lincoln Electric Company of Cleveland, Ohio.

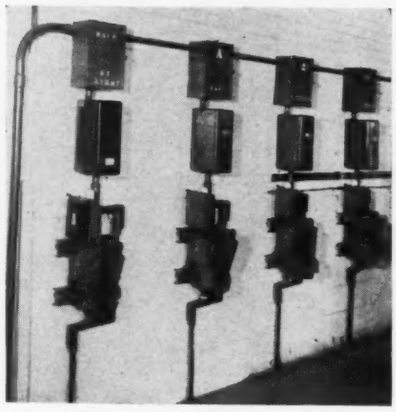


ELECTRIC arc welding was used for the second time to build up the teeth on these coal crusher rolls, avoiding replacement of the rolls

•

Breaker Solenoids Mounted in Open

To insure maximum accessibility of oil circuit breaker tripping and closing mechanisms at the Norwood (Mass.) lighting department substation all the solenoid and allied equipment was mounted behind the breaker cells on the further side of a 12-in. concrete wall separating the cells from an interior bus room. The breakers were fastened to the wall by hold-on bolts, two of which for each switch were seated in a 2x¼-in. copper ground bus carried along the wall as shown. The breakers are of the Conduit D-21 type, at present operated on a 2,300-volt bus, but rated at 7,500 volts, and thus to be utilized in connection with a future transition of the distribution system to 4-kv. service.



ACCESSIBILITY of breaker trip and setting mechanism was assured by locating units outside cells

There are fourteen breaker mechanisms mounted in this way on a 30-in. center-to-center spacing. Direct-current power for operating the mechanism is supplied through a conduit line at the top of the grouping (recommended size, 1½ in). Conduit hesitating type relays, trip-free, are mounted in cases below the fuse boxes, which occupy the upper part of the set-up, and below are the boxes containing auxiliary switches, pilot light connections, etc., the closing and tripping solenoids, and related control circuits run in conduit (recommended size 1¼ in.). The mechanisms are supported on 3x1¼-in. channel irons bolted through the wall, and the

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Just write Section M-190, Appliance and Merchandise Dept., General Electric Company, Bridgeport, Conn.

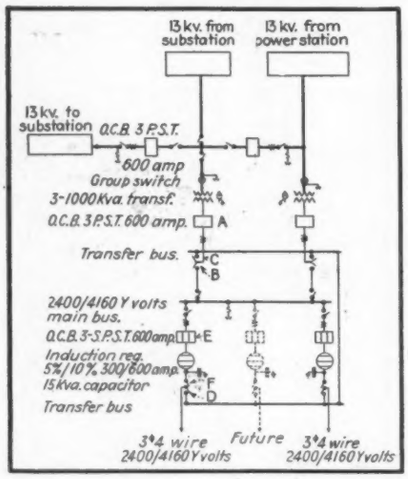
GENERAL ELECTRIC

equipment is all placed within 6 ft. of the floor. Inspection and repairs are facilitated in front of the wall by a working space from 3 to 6 ft. wide.

•

Capacitors Eliminate Arc Hazard

To absorb the energy in the arc drawn when disconnect switches are used to break the magnetizing current on feeder voltage regulators at a Nebraska Power Company substation company engineers have installed



CAPACITORS between phase wires and grounded neutral absorb arc energy in breaking regulator magnetizing current

15-kva. capacitors between each phase wire and grounded neutral, as shown in the accompanying diagram.

These capacitors were incorporated into the design of a distribution substation at the time of its reconstruction from 2,300 volts delta to 2,300/4,000 Y volts, four-wire. They are located on a steel frame support adjacent to the outdoor induction voltage regulators.

To isolate a regulator the sequence is to open oil breaker *A* and disconnect switch *B*, close disconnect switches *C* and *D*, run regulator to neutral position, close breaker *A*, open breaker *E* and disconnect switch *F*. The magnetizing current of the regulator is interrupted by the last disconnect switch *F*, but the arc is reduced by the capacitor to a safe value.

Previous to the use of capacitors, it was hazardous to open the exciting circuit of a regulator by disconnect switches and oil circuit breakers were commonly required. The saving in cost justified the use of capacitors in place of breakers apart from any consideration of the benefits derived from power-factor improvement.

The switching described should be done during light load conditions, when one transformer bank can carry the entire substation. To restore the regulator to service the procedure is reversed.

•

Effective Arc-Proofing For Power Cables

A simple, inexpensive fire- or arc-proofing treatment that experience on the Detroit Edison system has proved to be effective in protecting lead-covered power cables in manholes from damage by most arcs consists essentially of two layers of 3-in. wide, $\frac{3}{32}$-in. thick standard felted asbestos tape that has been immersed in 40 percent (by weight) silicate of soda solution prior to application. First layer of the saturated tape is butt wound over the cable and the second layer applied to cover gaps in the first wrapping.

Amount of material to fireproof the joint sleeve and an average length of 11 ft. of slack cable in a manhole would be two 45-ft. rolls of asbestos tape. This represents an average cost of fireproofing of 10-15 cents per foot of cable.

In recent months the company reports that it has been able to save about 25 percent in the cost of asbestos tape by purchasing 50-lb. rolls, 18 in. wide and 60 ft. long, and cutting the rolls to standard 3 in. and $1\frac{1}{2}$ in. widths in the company's shop.

Besides low material cost and satisfactory fire-resisting properties the arc-proofing treatment has the advantage that it involves no charge for labor since the splicer's helper can apply all fireproofing on a cable line in a manhole (duct mouth to duct mouth) except that on lead sleeve, while waiting for first and second pourings of joint-filling compound to cool.

A splicer crew is required to complete a joint on the company's three-shielded conductor 350,000-cir.mil, 24-kv. cable in eight hours, of which $1\frac{1}{2}$ hours is required for filling compound to cool before sealing the filling holes. Since this cooling time would otherwise be wasted, advantage is taken of it to apply fireproofing. All slack cable in the manhole and joint can usually be fireproofed in an hour. When importance of service warrants, a third wrapping of asbestos tape is applied.

•

Snowmobile Speeds Line Maintenance

Areas traversed by transmission lines which are difficult to reach in winter because of deep or drifted snow or in spring and fall because of mud and slush will be accessible to line crews of Utah Power & Light Company in the future. A snowmobile, constructed at the Grace power plant under the supervision of J. L. Jameson, superintendent of maintenance, will do the trick.

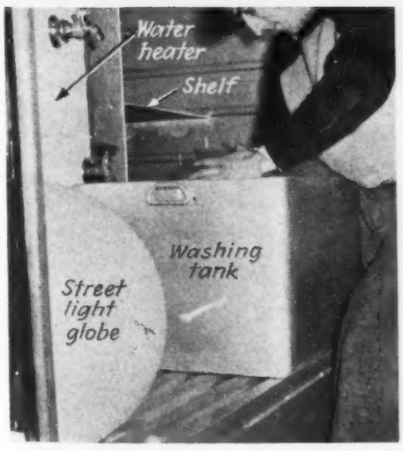
The snowmobile consists of a $\frac{1}{2}$-ton Ford truck body mounted on a "Snow Bird" undercarriage. Either wheels or skis can be used on front,

SNOWMOBILE takes line crews into inaccessible areas for winter maintenance work

the former for traversing mud and the latter for snow. It has a speed of 20 miles per hour in deep snow, has a seating capacity for a crew of eight and equipment includes tools and materials for making line repairs as well as a stock of emergency provisions. Because of its extreme flexibility it will save both time and money.

•

Water Heater Goes Mobile



Novel feature of a new ½-ton "step-in-and-drive" truck, acquired recently by the Indianapolis Power & Light Company for street light and maintenance, is a 60-gal. electric water heater. This water heater is "charged" each night while the truck is in the company garage. It leaves the next morning with a full day's supply of hot water for cleaning glassware. Shelves for cleaning materials and a large tank for washing the globes are also a part of the equipment.

Current-Loading of Ground Connections—I

By J. R. EATON *
Purdue University, Lafayette, Ind.

The extent to which the current-loading capacity of ground connections must be considered is of course dependent on the nature of the circuit attached to the earth connection, since the performance of this circuit will determine the magnitude and duration of the currents which may be imposed on the ground connection. Consideration should be given to three different types of loading: Current of low magnitude and long duration, current of high magnitude but short duration, large currents of long-time duration.

Current of low magnitude and long duration may sometimes be sent through a ground connection at points at which wye-connected transformers are grounded. Small neutral currents frequently flow in such circuits because of unbalances in the electrical circuit. Currents of somewhat higher magnitude may flow as a result of a permanent fault on the system, the resistance of the fault being high enough to produce a fault current below the operating point of automatic protective equipment. Faults of this kind sometimes occur a a result of contact between overhead lines and trees. In such case the power released as heat is relatively small and, because of the time involved, the effect of heat conduction and the movement of moisture due to capillary action is of importance in preventing the rise of the ground resistance by dry-out of the soil.

Electrode Temperature

Rise of temperature near the surface of the electrode is dependent on numerous factors not readily determinable, with the result that calculations are quite difficult. However, illustrative calculations have been made considering only the resistivity and the heat conductance of the soil. For these calculations the resistivity of the soil was taken at 10,000 ohms per cm. cube, while the thermal conductance was assumed at 1×10^{-12} watts /cm^3/degree C. Considering a spherical electrode having a diameter of 1 meter, it was found that with a current of 10 amp., it would take some seventeen days to raise the temperature of the soil at the surface of the sphere to 100 deg. C. However, if the current were raised to 110 amp., this temperature would be reached in one hour.

Although accurate calculations are impracticable for many cases, it is frequently possible to arrive at a fair estimate of the possibility of drying out by a consideration of the total I^2R loss which must be dissipated in the earth compared with the total area of the system of ground electrodes.

[ED. NOTE—This is the seventh in a series of articles on various phases of grounding.]

*Consultant for James G. Biddle Co.

•

Salvage Methods Save Aluminum Meter Parts

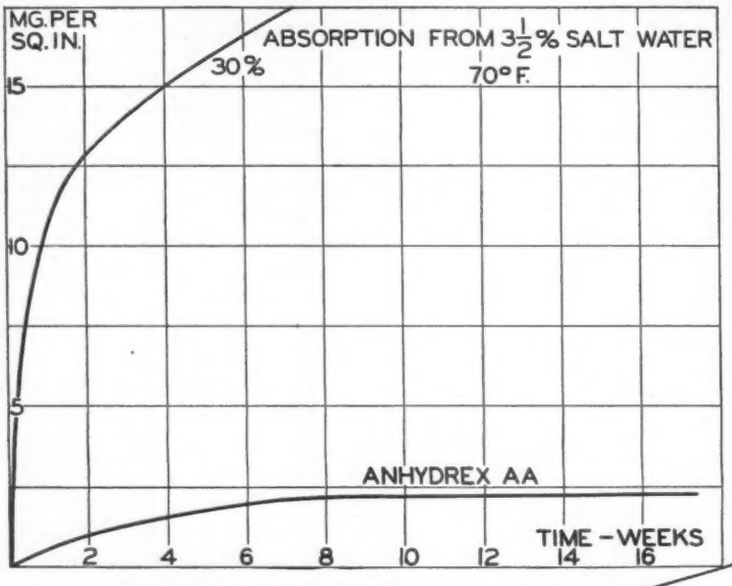
With aluminum at a premium, ways to salvage aluminum parts that might otherwise be scrapped are much in demand. Two such methods used in the meter department of the Central Illinois Public Service Company, Springfield, Ill., follow:

Aluminum watt-hour meter bases (mostly polyphase) in which holes have been burned by lightning are satisfactorily repaired with aluminum solder. Some material such as horn fiber or sheet asbestos is clamped over the hole on the inside of the meter base. The hole is then filled with aluminum solder from the outside, using a conventional soldering copper. A repair consumes about fifteen minutes of time and 10 cents worth of material.

Aluminum watt-hour meter disks that have been exposed to a short circuit, which might have thrown a deposit of iron on the disk, are tested with a couple of chemical reagents. Formerly, the disks so exposed were scrapped without test. Reagent first applied to the suspected spot is a dilute (1/1) solution of hydrochloric acid. To this is added a drop of a weak aqueous solution of potassium ferrocyanide solution (not particularly poisonous). Presence of iron is indicated by a blue color.

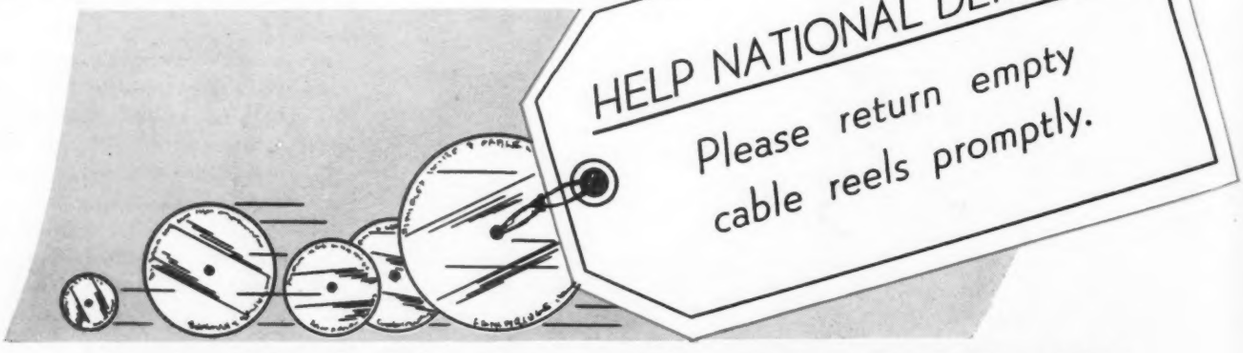
If iron were present in any appreciable quantity on the disk it would cause the meter disk under no-load conditions to stop with the iron deposit under the magnets and require more than an ordinary amount of current to start the meter again, resulting in inaccurate registration.

Your Cables are 'Out' when *Water* gets in—



Simplex-ANHYDREX deproteinized rubber cable insulation will not admit water. It needs no lead sheath.

Ask for descriptive booklet "ANHYDREX Rubber Insulation for Wires and Cables."



Simplex Wire & Cable Co., 79 Sidney Street, Cambridge, Mass.

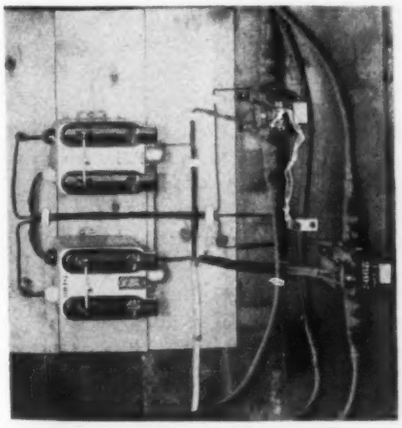
SIMPLEX WIRES CABLES

INDUSTRIAL ENGINEERING

Wiring Gravel Plant Meter Layout

In supplying energy to the Acme Sand & Gravel Company, Woburn, Mass., from a Boston Edison step-down transformer station it was important to protect the meter and instrument transformer connections from heavy dust conditions common to such establishments, and to do this economically. The Acme company operates eleven motors with a combined rating of about 230 hp. on three-phase, 550-volt circuits, and the installation includes three 15-kva. G.E. capacitors located at individual motors for power-factor improvement.

The metering and main switch installation was made in a wooden house



INSTRUMENT TAPS cabled to protect low-potential wiring

located centrally on the property, and was compactly arranged by running a three-phase, 550-volt main feeder from the transformer bank through a hand-operated main switch of the inclosed type, thence past an instrument transformer terminal board, and out in cabled assembly to distributing points. Current transformers for the metering set-up were wired into two legs of the feeder and taps taken off as shown to the metering potential transformers assembled above on a simple wooden panel. All the leads running to the reactive kva. and watt-hour demand meters were then run together with the current transformer secondary leads in a combination cable terminating at the meter cabinet. The wiring layout, free from complexity, is readily followed by the open arrangement of conductors, and repairs or changes can be made with minimum loss of time.

In this plant the power factor was raised from about 65 percent to 85 percent by the use of the capacitors, combined with various motor changes to secure better loading of units and the reduction of excess motor capacity.

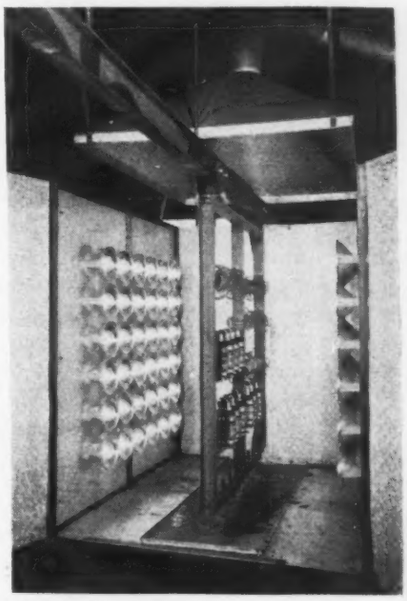
•

Infra-Red Bakes Coils and Armatures

Radiant energy bakes insulating varnish on coil windings and motor armatures in the Pyle National Company factory, Chicago, in about half the time previously required by its steam ovens.

Present practice of the company is to preheat the coils and armatures in a steam oven, dip them in synthetic impregnating varnish and bake them in the infra-red oven shown. This oven, which is 74 in. long, 58½ in. wide and 72 in. high, incloses two vertical banks of 36 250-watt lamps each mounted in 8-in. Alzak reflectors arranged rim to rim in six rows of six lamps each. Walls of the oven on which the lamps are mounted are movable and can be adjusted to bring the lamps to the optimum working distance.

Distance from the lamps to the



INCLOSED BANKS of infra-red lamps bake varnish on coils and armatures in half the time required by steam ovens

rack in most cases is kept around 24 in. since it is desirable to keep the temperature below 275 deg. F. to avoid decomposition of the impregnating varnish or charring of the insulating tape on the coils. Coils and armatures are suspended in a channel-iron rack hung from a monorail so that it can be run in one side of the oven and out the other.

Prior to the installation of the lamp banks a steam-heated oven was used, but results with it were not entirely satisfactory. Also, with the increase in business volume surplus steam was not always available for

this work. Using the infra-red lamps a satisfactory bake can be obtained in four hours, where eight to nine hours was required in a steam oven.

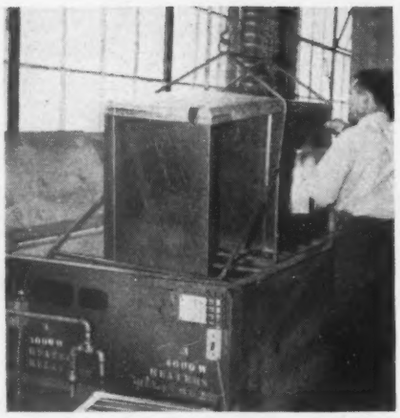
Extensive time temperature tests have been run using various lamp-to-work distances. It is notable that coils with white tape dipped in clear varnish attain a surface temperature some 30 deg. C. above that for black insulating tape and clear varnish.

•

Electric Heat for "Degreasing" Fluid

Successful application of various paints and sprays depends upon the absolute cleanliness of the surfaces to which they are applied. This is particularly true of processes where infra-red drying is used. To assure perfect cleanliness, particularly from grease, the Thermador Electrical Manufacturing Company, Los Angeles, has developed an electrically heated "degreasing" tank in which all parts to be sprayed are first dipped.

Two banks of heaters totaling 21 kw. maintain a solution of carbon tetrachloride and other materials having a low boiling point at a uniform temperature of 140 deg. F. The special tank is deep enough to permit complete immersion of the parts to be cleaned. Over the surface of the cleaning fluid there is a layer of cool water that prevents the vapors from being carried off into the room. The solution cuts the grease in about 30 seconds. The rise in temperature of the part immersed is such that the heat dries off the water immediately. Temperature control is maintained thermostatically and an electrically driven pump maintains a constant level of cool water.



THIS "degreasing" tank for cleaning parts to be painted or sprayed is maintained at 140 deg. F. by 21 kw. of electric heaters

•

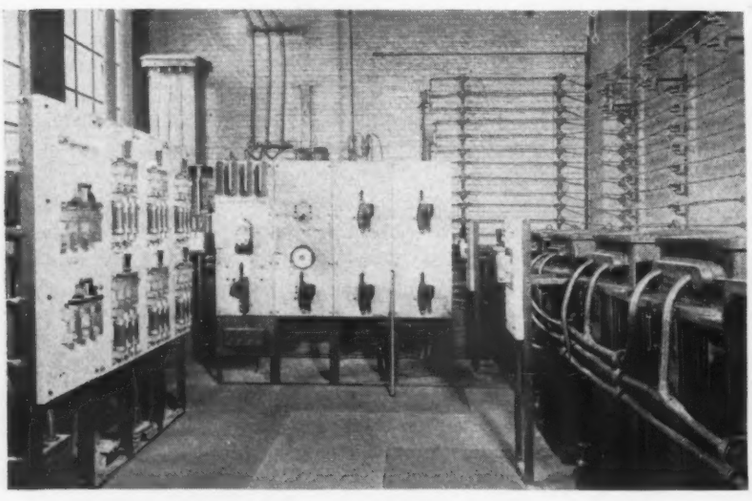
Modernization with Capacity Increase

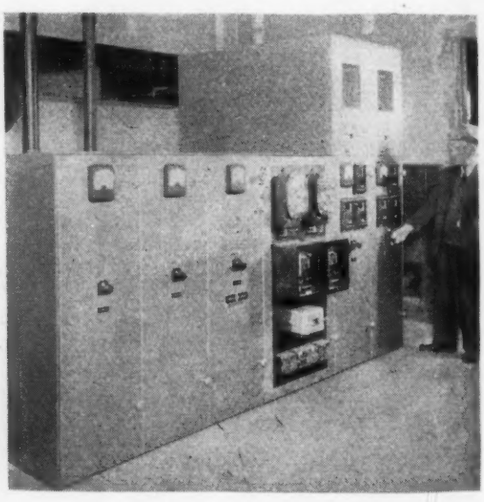
By E. O. JONES
General Electric Company, Buffalo, N. Y.

More capacity in present space is the usual requirement in the industrial substation when loads outgrow existing supply facilities. How modernization solves that problem is nicely shown in the case of the Hewitt Rubber Corporation, Buffalo, N. Y. Erection of new buildings and installation of new equipment, including several large synchronous motor drives, made additional transformer capacity necessary. Simply to install another bank in the substation looked pretty difficult because the space already contained eighteen transformers in four banks of 300 kva. each for power and six 25-kva. units for lighting single-phase supply plus three switchboards for power and lighting distribution and for incoming primary lines.

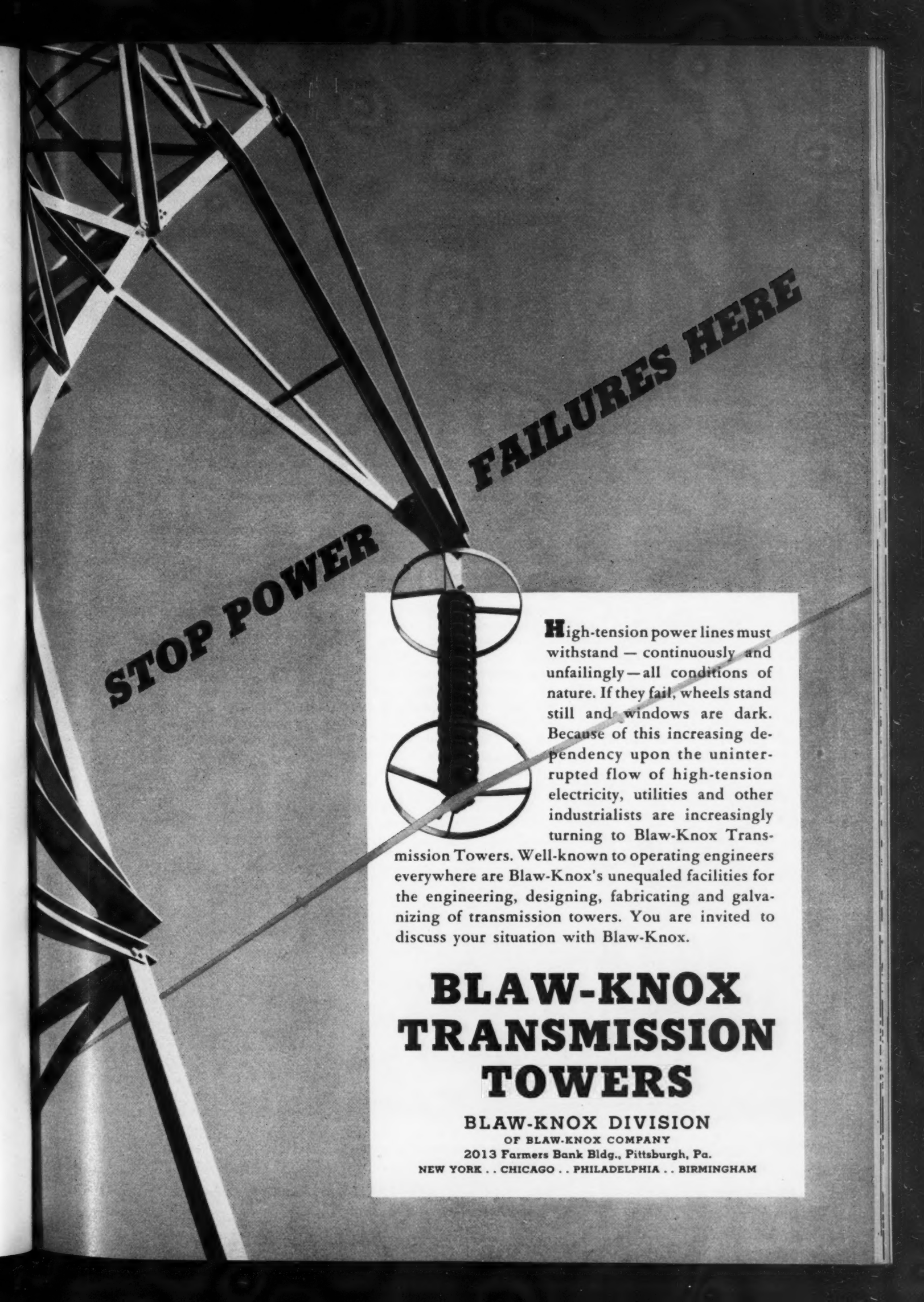
Modernization appeared to be indicated and study of primary and secondary switching equipment, including analysis of the interrupting capacity of the incoming line breakers, proved that it was, very much so. And the end result was a handsome, uncrowded substation that not only contained the full requirement of capacity with room for future addition but also allowed a fire wall between the transformers and the switchboards.

Transformer equipment now consists of six units instead of eighteen; three 500-kva., 2,400/460-volt, 25-cycle transformers for power supply and three 100-kva., 2,400/208-120-volt, 25-cycle transformers connected with secondaries star-connected to provide three-phase, four-wire lighting supply. Metal-inclosed air circuit breakers are used on the secondary distribution, the breakers for both light and power circuits in one assembly to which the secondaries are carried in bus direct from the transformers. Metal-clad switchgear is used on the primary side, which includes two incoming lines, three outgoing feeders and the power company's metering equipment. The accompanying pictures show the change from the old to the new.





INDUSTRIAL SUBSTATION before and after modernization. At left the old secondary distribution board, primary board and a few of the eighteen transformers. Other picture shows the new primary switchgear



High-tension power lines must withstand — continuously and unfailingly—all conditions of nature. If they fail, wheels stand still and windows are dark. Because of this increasing dependency upon the uninterrupted flow of high-tension electricity, utilities and other industrialists are increasingly turning to Blaw-Knox Transmission Towers. Well-known to operating engineers everywhere are Blaw-Knox's unequaled facilities for the engineering, designing, fabricating and galvanizing of transmission towers. You are invited to discuss your situation with Blaw-Knox.

BLAW-KNOX TRANSMISSION TOWERS

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
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LOAD BUILDING

"Home-Town Paper" Promotion Slant

A "home-town newspaper" angle, rather than reliance on manufacturers' sales and illustrative material, has been employed in a continuing series of colorful broadsides—featuring local commercial cooking installations, including excellent testimonials from operators employing all-electric equipment—which are doing an interesting, profitable contact job for the Idaho Power Company. Personally signed letters from Idaho Power commercial salesmen accompany each mailing to customers and prospective all-electric clients, providing an agreeable introduction for a personal call.

According to Orland C. Mayer, commercial and industrial sales manager, the success of the campaign rests on continuity—constant reminders to the readers that electric cookery is widely accepted and progressive. The testimonials bear out economy, cleanliness and speed of electric equipment, and accompanying pictures show it in use in the operator-testifier's own restaurant. Also included prominently in the broadside is a list of equipment employed—important because it may give some new ideas to part-electric operators, and generally stimulate appliance sales.

Testifying to the interest shown in the broadsides is the fact that many restaurant owners and managers keep a file of them, possibly for new ideas on equipment and design, as well as reports on others' experiences in their field with electric cooking.

Tillotson's Find that Adding Service Reduces Average Rate
Low commercial cooking rates are an important factor in Tillotson's operation. Step-down rates have made it possible for this restaurant to add more equipment and keep operating costs low. Electric Cooking is particularly desirable where the speedy handling of customers is urgent during the rush hours.
BUSY
ECONOMICAL
IDAHO POWER
It will pay you to investigate
ELECTRIC COOKING

STRONG on local interest, colorful broadsides such as this do an interesting, profitable contact job for Idaho Power and pave way for commercial man's sales call

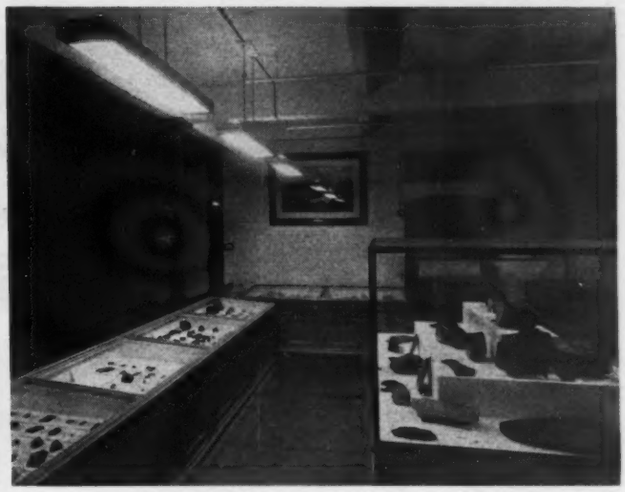
Another interesting report from Mr. Mayer is that numerous requests have been received by Idaho Power from restaurateurs to feature their establishments in forthcoming broadsides. Slogans on the outside of the envelopes, different in text but alike in form, have aided the "another electric installation" angle, according to the company.

•

Fluorescent Lighting for Glass Flowers

Harvard University's unique collection of glass flowers at Cambridge, Mass., has recently been relighted with fluorescent units better to bring out the color and structural details of this extraordinary display. Located at the University Museum on Oxford Street, the exhibit has attracted visitors for many years from all over the world. Through the courtesy of G. K. Saurwein, superintendent of engineering at the university, the following details of the new lighting layout are presented, including a further application of fluorescent units to the minerological section of the same building.

The former lighting of both exhibits was by tungsten lamps in translucent fixtures, giving an intensity of 3 ft.-candles or less at the display cases. In the new installation, for which the Thompson Engineered Lighting Co., Boston, was consultant, co-operating with R. B. Johnson, superintendent of maintenance at Harvard, the major objective was to raise the intensity to about 15 ft.-candles in the glass flower exhibit and to about 30 ft.-candles in the mineral section, eliminating glare to the utmost degree feasible in each case.



Miller trough type units illuminate world-famous glass flower display at Harvard (left)
Art metal units bring out colors in mineral display (right)

This has been effectively accomplished, as the illustrations indicate, and with the result that the natural colors of the simulated flowers and their magnified parts appear as never before. Visitors remain longer in the exhibits and study the details more thoroughly. In the mineral exhibit the same thing is true, and the objects are revealed literally in a new light.

Miller troffers 16 ft. long, each containing four 40-watt white tubes and equipped with baffles 12 in. apart, are mounted above the glass flower cases. The bottoms of the troffers are 5 ft. 6 in. above the surfaces of the cases and 35 in. below the ceiling. The troffers are 7 in. deep, 10 in. wide at the top and 12 in. wide at the bottom. The cases are 26 in. wide (central double section 52 in. wide), and their tops are 42 in. above the floor. In the room section illustrated the nearer aisle is 47 in. wide and the further aisle 36 in. wide, the troffers being placed substantially over the aisle centers. Wall cabinets are 46 in. high x 9 in. deep, 27 ft. 6 in. long over all, and the center counters are about 32 ft. long. The troffers are suspended by chains from the ceiling and are given an eggshell enamel on the inside surfaces. The horizontal display cases are 9 in. deep. The baffles were provided to cut out glare in the aisles.

The mineral display, of which one section is shown with a meteorite cabinet at the right, is equipped with horizontal cases 38 in. wide and extending along the side and end of the area. The lower edge of the case is 33 in. above the floor and the fixture (Art Metal, Cleveland, Ohio) height is about 6 ft. above the case and 1 ft. below the ceiling, suspension being by ½-in. aluminum pipe supports. Three fixtures are used on this side of the room, each 50 in. long, 9 in. wide and 3 in. deep, two 40-watt daylight tubes being used per unit. The meteorite case is 8 ft. 3 in. long x 5 ft. 9 in. wide at the top, 33 in. from floor to display surface and 35 in. deep, with a 53-in. aisle at the left.

Electric service at the museum, as in other Harvard buildings in Cambridge, is furnished at 13 kv. by the Cambridge Electric Light Company to the Harvard substation for distribution over the university network. The museum requirements are in general of the long-hour type of load, influenced largely by daylight conditions.

• • •

Composing Room Relighted with Fluorescent and Incandescent

Before and after relighting the composing room of the *Leader Press*, Oklahoma City, Okla. General illumination in the 32 x 76-ft. production area was 12 ft.-candles before, 65 ft.-candles after 300-watt incandescents were installed in glass luminaires. Note substitution of fluorescents for incandescents above tables at right and in background, also shielding of the fluorescents

THE FLUORESCENT LIGHTING MARKET IS HOT AND GETTING HOTTER . . .

250 MILLION DOLLARS is the estimated expenditure for fluorescent lamps, fixtures, and installations this year. In 1940 it was under 100 million. These figures include no expenditures for production expansion. At the present growing rate the first billion-dollar year is not far off.

G-E MAZDA LAMPS

1. PLENTY OF DISTRIBUTORS in your territory need more information about fluorescent selling methods, lighting layouts, and service data. Many utilities find they can develop their fluorescent lighting market by actively sponsoring trade meetings once a month to provide this much-needed assistance. General Electric has a program complete with slide films and manuals for putting on such trade meetings.

2. TEST CAMPAIGNS IN NEWSPAPERS and by direct mail bring out many worthwhile leads. They tell "the rest of the fluorescent lighting story", i. e., what fluorescent lighting *gives* rather than what it saves. G.E. has suggestions for local advertising including mats and direct mail pieces.

3. HUNDREDS OF LIGHTING SALESMEN report that the use of the Footcandle Selectometer along with the Light Meter is most effective since it lets *customers* determine how many footcandles they need for better seeing. Are you using *both* of these devices in your fluorescent lighting sales work? G.E. can supply you.

4. SURVEYS INDICATE that two out of three fluorescent lighting installations are *bought*, not *sold*. They also show that a poor installation of the 10-footcandle variety is apt to inspire two or more other 10-footcandle jobs. Setting up good visual standards in every buying center . . . say a 50-footcandle installation as a standard of comparison . . . is an effective way to inspire more 50-footcandle installations.

5. LOCAL FLUORESCENT CONSUMER EXHIBITS and demonstrations to acquaint the public with the best usage of fluorescent lighting are proving most effective in increasing sales. G.E. has complete plans for staging such exhibits.

6. MANY UTILITIES have found that installing 50 to 100 footcandles in certain of their own stores and offices is another effective way to give visible evidence of what they are selling. Are you using this method?

7. THOSE UTILITIES participating in the 49-Footcandle Club find they are getting a more representative share of 50-footcandle installations on their lines. General Electric will be glad to help you organize your own 49-Footcandle Club. See your G.E. lamp division office.

GENERAL ELECTRIC

NEW ENGINEERING IDEAS

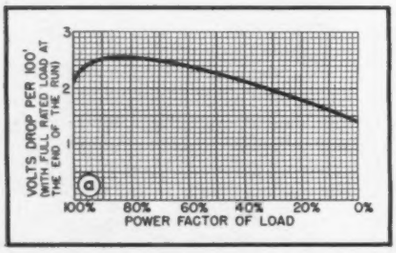
Interleaved Phases for Welder Bus

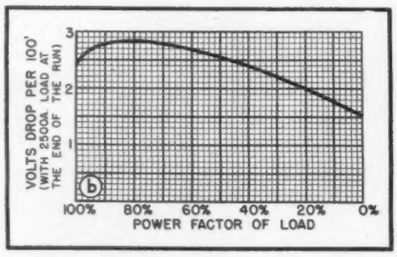
By L. E. FISHER
Director of Research
Bull Dog Electric Products Company, Detroit

For heavy-current a.c. circuits to welders, furnaces and induction ovens it is most desirable to reduce voltage drop as nearly as possible to the d.c. values. To do so it is necessary to minimize the magnetic fields so that effects are kept low. This is accomplished in LO-X BUStribution duct by splitting the phase bars and arranging them in flat pairs which associate phases A and B, B and C, and C and A for three-phase. For single-phase runs the going and return conductors are parallel flat bars likewise very close together.

Minimization of the alternating flux permits the use of steel for the casing with negligible increase in reactance and small eddy current or hysteresis losses. The supporting porcelain insulators are in compression and their mounting affords resiliency which cushions insulator shock in case of short circuits. The bars are ¼ in. apart and between them is a 0.03-in. sheet of varnished fiberglass, held by the edges of the duct.

Tests show that, even for the low power factors often encountered in welder and furnace circuits, the total voltage drop is well within a range that assures good voltage to the production equipment.

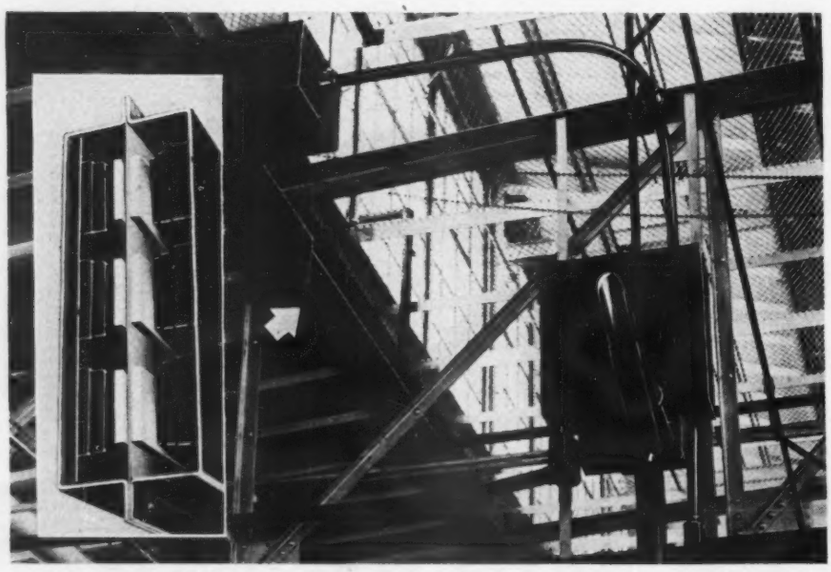




LOW-VOLTAGE DROP attained for both single and three phase

(a) For all sizes from 500 to 6,000 amp. of single-phase with full rated load at end of run.

(b) For 2,500-amp. load at end of three-phase, 2,500-amp. run of LO-X bus.



WELDER supply in 2,000-amp. low-reactance bus duct. Insert shows split-phase arrangement, steel casing, porcelain insulators and fiberglass separator

•

Transmission Formula Is Reasonably Exact

By B. E. ELLSWORTH
Electrical Engineer
Iowa-Nebraska Power Company, Lincoln, Neb.

There are several accurate transmission line regulation formulas which are well known to engineers, but they are long and some of them require the subtraction of large numbers which introduce large errors when slide rules are used. By accurate formulas is meant accurate when distributed capacity between conductors is omitted. (Distributed capacity can most easily be accounted for by assuming an improvement in power factor.) This capacity effect on voltage is low even in 115-kv. systems.

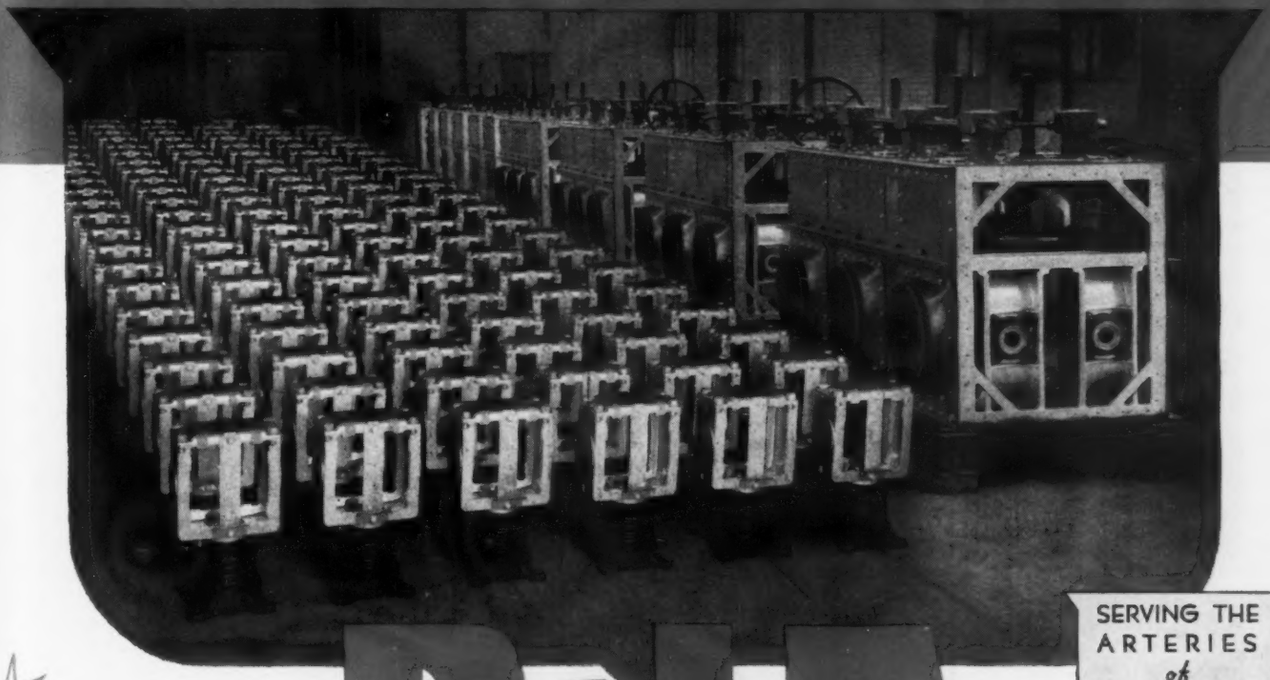
The convenient formula, known to most engineers, is:

$$E_s = E_R + I_p R \pm I_q X$$

ONE WAY

to be PATRIOTIC... buy Quality

NOW, when pressure of defense requirements is taxing the wits and capacities of manufacturers, NOW is the time to look to the quality of service and equipment as never before. It's good business, and patriotic as well, to demand the most service from raw materials which are being rationed to manufacturers. ¶ Over and above our sharing in the production of defense materials, we dedicate our other resources to the industry of our first association, the Public Utilities. ¶ With your full co-operation in long range planning and latitude of specifications, we can help your position by eliminating many of the unnecessary delays accompanying these emergency conditions.



SERVING THE ARTERIES of INDUSTRY

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READY IN EMERGENCIES

RAILWAY AND INDUSTRIAL ENGINEERING COMPANY, GREENSBURG, PA.

Manufacturers of Outdoor and Indoor Hi-Pressure Contact Switching Equipment, Bus Supports, Metal Enclosed Buses and Switches, Distribution Cutouts and Switches, Interlocks, Automatic Switching Systems, Heavy Duty Channel Bus Structures and Substations.

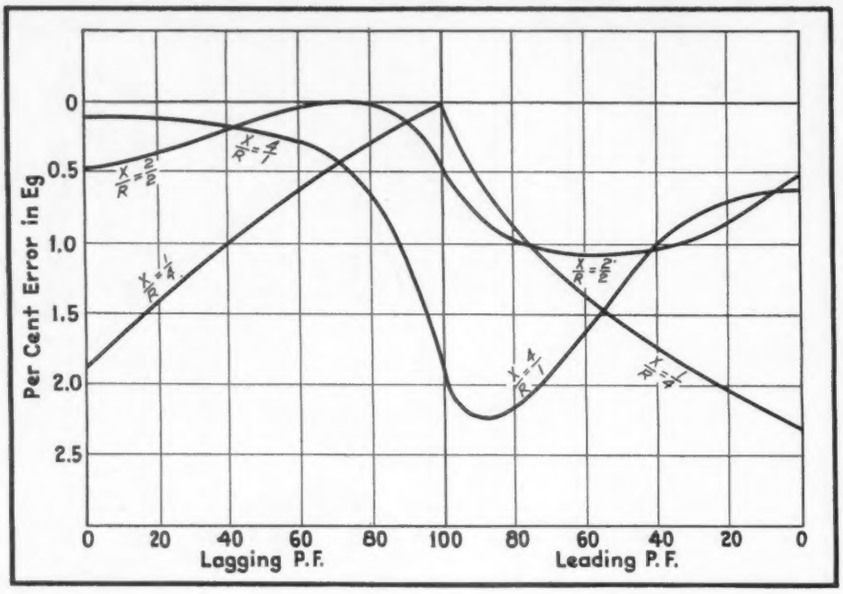


CHART shows that the short transmission line formula is accurate to 1 percent for ratios and power factors

The voltage drop in the line is:

$$E_s - E_R = I_p R \pm I_q X$$

The generating and receiving-end voltages are to neutral. R and X are the resistance and inductive reactance of the system or line respectively. I_p and I_q are the components of the current in phase and in quadrature with the voltage respectively.

The I_qX term is positive for lagging power factors and negative for leading power factors. Voltage drop and regulation can be figured by adding and multiplying small numbers. While the formula is called approximate, yet the results, if calculations are done on the slide rule, may easily be more accurate than if the longer formulas are used.

The accompanying curves show the error that may be expected when using this formula for different $\frac{X}{R}$ ratios and power factors. These curves were prepared by using an example with a high voltage drop (average around 10 percent) so they may be considered as giving the probable maximum error in the value E_s for any given $\frac{X}{R}$ ratio.

From the curves it will be noted that this formula can be used with 1 percent or less error in the results if the following power factors and $\frac{X}{R}$ ratios are omitted:

1. For $\frac{R}{X}$ ratio of $\frac{4}{1}$. Power factors are between 90 percent lagging and 40 percent leading.

2. For $\frac{X}{R}$ ratio of $\frac{1}{4}$. Power factors below 40 percent lagging and 80 percent leading.

In general, when the reactance in a line is high errors will be experienced near unity power factors. Where the resistance of line is high errors will be experienced at low power factors. The convenience and ease of using this simple formula are very apparent and it can be safely used if the resulting error is known.

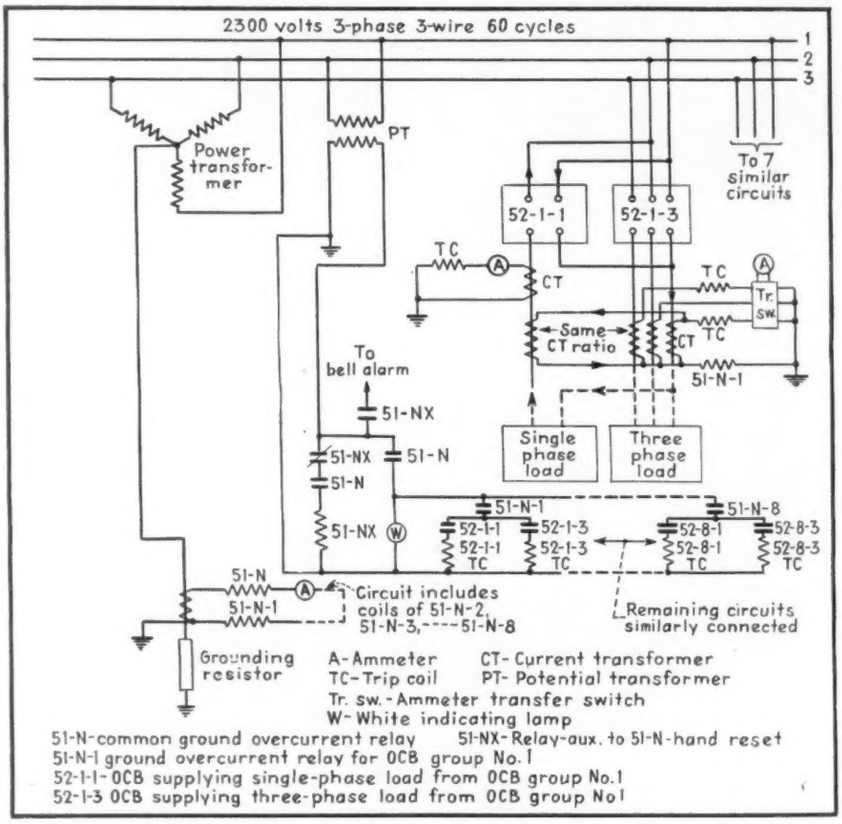
•

Ground Indicating Scheme for Feeders

By A. E. ANDERSON
General Electric Company, Philadelphia, Pa.

A ground alarm and protective scheme has been developed for a distribution system consisting of eight groups of feeders, each group comprising one three-phase power circuit and one single-phase lighting circuit. The three-phase and single-phase circuits have one common conductor. The scheme was recently supplied to Cia Electrica De Bucamerango, Santander, Colombia, S. A.

One of the more conventional



PROTECTIVE and ground alarm scheme for use with single- and three-phase circuits having one conductor in common.

Secondary of current transformer in single-phase circuit is connected to secondary of current transformer in three-phase circuit through which both single- and three-phase current flows. Current induced by single-phase load circulates between these two current transformers. Current induced by three-phase load is confined to devices associated with three-phase circuit.

TWO FEDERAL AGENTS ENTER FIRE PROBE— SABOTAGE "POSSIBLE"
Federal agents arrived today to take part in the investigation of the disastrous fire that stopped production on important defense

Learning The Cause Won't Fill The Orders

The shafts have stopped turning. Hands that can set a tool-rest to a hair are wrapped around pool cues down at Joe's place. Mirror finishes on Assembly's floor are dimming over with the first hints of rust.

Learning the cause of your fire won't help. What you wanted was the chance to produce – without Fire's interruption. Perhaps you counted on a "fire-proof" building. Or on employees trained to be ever-watchful. *You can't* – as the record of thousands of fires will show. The record proves that there's only one way to stop fire at its source. That way is automatic sprinkler fire protection.

Fortunately, there isn't the slightest need to compromise with quality when you install it. For the world's best-known fire protection system – Grinnell – can be bought as an actual cash-dividend-paying investment. The chart below proves it.

Built lock, stock and barrel by the world's leader in fire protection; prefabricated to a Grinnell-engineered layout, then installed with minimum disruption; proved dependable by eight thousand fires killed in the past ten years alone – a Grinnell System is the best guardian of spinning shafts your plant can have. Owners of fifty billion dollars' worth of the world's property have chosen it. Take *your* first step today. Write Grinnell Company, Inc., Executive Offices, Providence, R. I. Branch offices in principal cities.

QUESTIONS and ANSWERS
about Automatic Sprinkler Fire Protection

Q. Who says I'm not protected? I have complete insurance coverage!

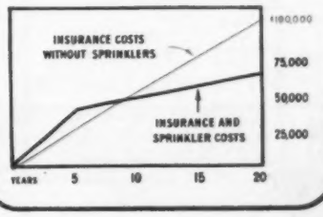
A. 43% of all burned businesses are never resumed, regardless of insurance.

Q. My building is metal; its contents are non-combustible. Why should I have sprinklers?

A. A metal mill burned to ruins in an afternoon. Oil vapor had condensed on inside walls.

Q. What do you mean – a Grinnell System pays for itself?

A. The chart shows a typical case. Insurance without Grinnell System, $5,000 yearly. With Grinnell, premium reduction paid for the system in 8-1/3 years. After that, $3,000 a year clear saving!



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ENGINEERED FIRE PROTECTION **FOR UNINTERRUPTED PRODUCTION**

Grinnell Company, Inc. • Grinnell Company of the Pacific • Grinnell Company of Canada, Ltd. • General Fire Extinguisher Company • American Moistening Company • Columbia Malleable Castings Corporation • The Ontario Malleable Iron Company, Ltd.

Introducing
A New
COMMERCIAL
ELECTRIC RANGE

AKRON
KITCHEN-KING

For Increased
Commercial Loads
and Electric Cooking
SATISFACTION

A real advance in design the heavy duty "Kitchen-King" offers exceptional adaptability and improved cooking conveniences at a moderate price. For flexibility, the cooking surface and bake oven are constructed sectionally and may be purchased separately for any arrangement. All of the advantageous economies and accuracy of electric cooking are provided — three-heat switches control each half section of the three 12"x24" cooking surfaces—top and bottom oven heat separately controlled with three-heat switches—yes, your customers will appreciate the fast, efficient cooking with "Kitchen-King". We invite your investigation.

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COMPLETE INFORMATION

AKRON
ASSOCIATED PRODUCTS, INC.
275 W. Market St., Akron, O.
Engineered Electrical Cooking Equipment and Appliances

ground indicating schemes (in the neutral of the power transformer) previously used did not indicate which circuit was grounded. Of course, on ground indication, it would be possible to open the circuit breakers and, by the process of elimination, determine which circuit was grounded. It became desirable to include in each feeder group some means which would indicate on which feeder group the ground occurred and, in addition, would automatically trip the proper circuit breaker or breakers and sound an alarm.

Control Circuits

Referring to the accompanying diagram and assuming that circuit breaker 52-1-3 is open and circuit breaker 52-1-1 closed, supplying single-phase load, it will be seen that the induced current is confined to the secondaries of the two current transformers, as indicated, and that none of this current flows in the parallel circuit formed by coil of relay 51-N-1, ammeter and trip coil.

When circuit breaker 52-1-1 is open and circuit breaker 52-1-3 is closed the ground protection functions in the same manner as in a conventional three-phase circuit, utilizing a relay responsive to the zero-phase sequence (residual) current.

If both circuit breakers 52-1-1 and 52-1-3 should be closed simultaneously and each is supplying load, the effect of the single-phase current will be subtracted from the output of the current transformer located in the common conductor.

Each single- and three-phase circuit has its own oil circuit breaker, ammeter and overcurrent tripping means for phase-to-phase faults, while the phase-to-ground responsive means is common to the two circuits.

A current transformer of lower ratio than those in the distribution circuits and a current-limiting resistor are connected in the neutral circuit of the power transformer. By the use of a wattmetric relay (51-N-1) having one of its coils in the residual circuit of the feeder current transformers located in the transformer neutral circuit, it is possible to obtain an operating point below that of the common ground overcurrent relay 51-N, which, in effect, determines the operating point of this combination of devices. The polarizing coils of the remaining seven wattmetric relays are connected in series.

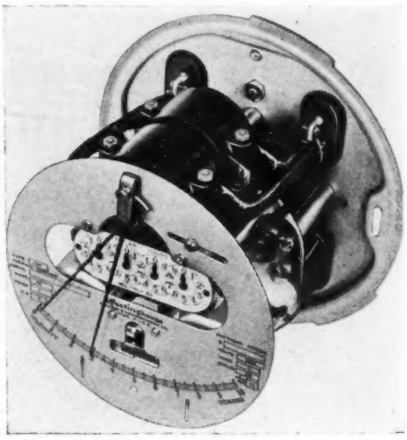
When ground current of sufficient magnitude is obtained on either the single- or three-phase circuit, device 51-N energizes an auxiliary relay, 51-NX, which sounds an alarm, and at the same time energizes a bus to which is connected a white indicating lamp, as well as the contacts of the ground overcurrent relays of the various circuit breaker groups. If a ground should occur on either the single- or three-phase circuits supplied by circuit breakers 52-1-1 or 52-1-3, relay 51-N-1 will complete a circuit to the trip coils of the former circuit breakers, tripping whichever circuit breaker is closed. A target on the various relays shows the group to which the tripped breaker is connected.

•

Thermal Demand and Watt-Hours Combined

By PAUL MacGAHAN
Meter Division, Westinghouse Electric & Manufacturing Company, Newark, N. J.

Advantages of the demand system of rates for electric service have continuously inspired a desire to extend these rates to the smaller loads. The familiar block interval or motor-timed



COMBINATION watt-hour and thermal demand meter

demand register built into a standard watt-hour meter as a complete unit was a step in this direction.

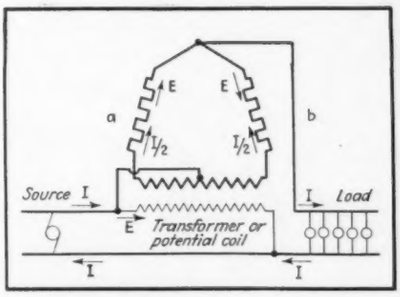
To extend the demand rate system to still smaller loads, it is necessary to have a meter which is sufficiently simple to require practically no more maintenance than the watt-hour meter itself and to be sufficiently low in price.

An answer to this problem has been found by reviewing in modified form

the earliest development of the thermal demand meter.

These early demand meters, however, were separate units from the watt-hour meters and thus required the installation of two meters for any given load. This condition was sufficient to deter their use for the smallest industrial loads in question.

In the new meter illustrated the thermal wattmeter principle is applied to measuring the demand and is combined ingeniously with a conventional induction type watt-hour meter to form a single self-contained unit.

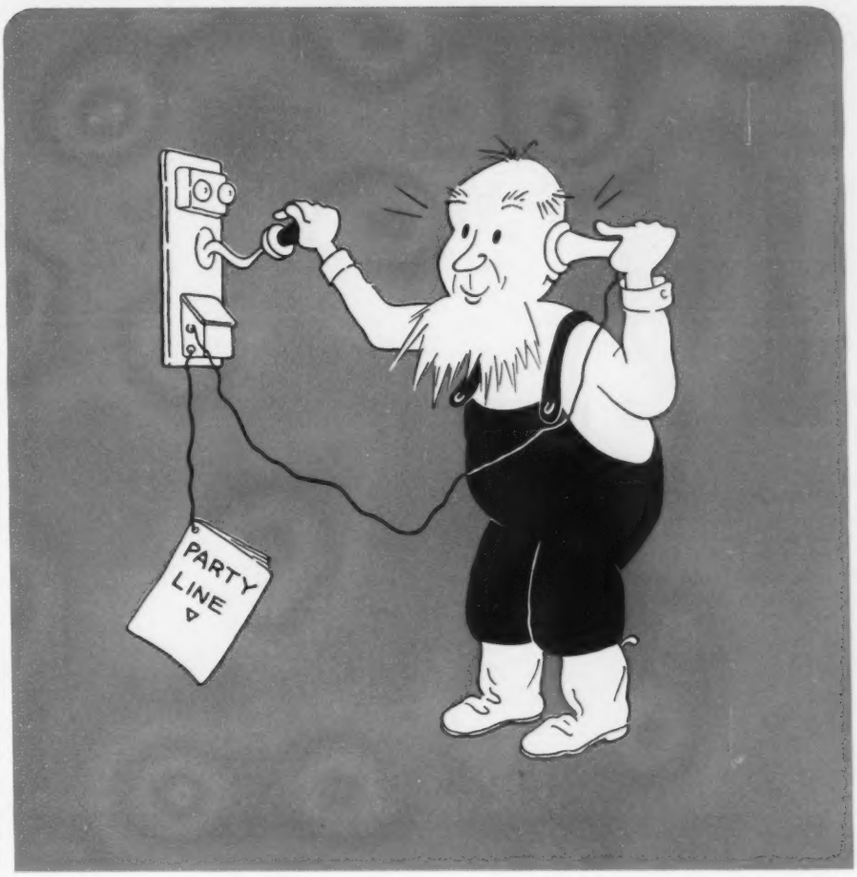


ELEMENTARY DIAGRAM showing principle of operation of the thermal method of measuring power

Explanation—Current I divides and passes through two equal heaters, a and b. The current E is proportional to line voltage and circulates in the direction indicated by the arrows. The quantities E and I must be considered as vectors. For a, current $= E + \frac{I}{2}$ For b, current $= E - \frac{I}{2}$ (1) a heating $= (E^2 + EI + \frac{I^2}{4})r$. (2) b heating $= (E^2 - EI + \frac{I^2}{4})r$. These two values (1) and (2) are subtracted by the differentially wound bimetal springs which are heated by the coils a, b, and operate the demand pointer. Then $a - b = 2EIr$, a quantity proportional to watts.

This complete one-unit combination is made possible because the transformer, which was self-contained in earlier thermal meters, is eliminated. Instead, the voltage component of the thermal element is fed by a secondary coil wound directly over the potential coil of the watt-hour meter, which, therefore, functions as a transformer. It is interesting to note that the current in this secondary coil has no appreciable effect on the quadrature adjustment of the watt-hour electromagnet.

This arrangement is facilitated by an improved design of the thermal unit, which in connection with carefully worked-out heat storage and insulation greatly reduces the required operating energy.



We Listen in, Too!

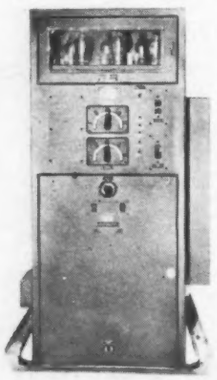
BUT we don't eavesdrop—we cooperate! From the moment of conception, Southern States has had determination *not* to put products on the market merely to sell something, but to create electrical equipment that solves a definite problem. This determination is still the guiding policy of Southern States. Our development engineers still go into the field with sleeves rolled up to find gaps that need filling. That's why Southern States' equipment does its job so dependably. Southern States' tried products are improved in anticipation of changing trends; new products are developed to meet new needs.

Southern States
EQUIPMENT CORPORATION
Manufacturers of High Voltage Electrical Equipment
BIRMINGHAM, ALABAMA
Representatives in Principal Cities

NEW EQUIPMENT

Welder Control

New capacitor-discharge control is designed for use with stored-energy type resistance-welding machines. Two tap switches select the number of capacitors



Capacitor-discharge control for resistance welding; includes 22 capacitors. **General Electric Co.**, Schenectady, N. Y.

desired in one-unit steps, each of 120 mfd. Operation of welding machine is prevented if capacitor voltage is more than 3 percent below its pre-selected value. Safety devices such as discharge contactor, circuit breaker and interlocks are included.

•

Fluorescent Tester

Pocket size instrument is available to determine cause of failure of fluorescent lamps, starters and ballasts to operate properly. It has two starter adapters for testing, two receptables for testing starters, and a glow lamp. Fixtures need not be removed from ceiling.

Fluorescent tester; suitable for 15- to 100-watt fluorescent lamps, as well as starters and ballasts for the respective lamps. **Mitchell Manufacturing Co.**, 2525 Clybourn Ave., Chicago, Ill.

Relays

"Bulletin 106" midget relays; maximum contact capacity based on non-inductive load; up to 220 volts, 4 amp. on single break, 6 amp. on double break, d.c. and a.c.; 23 to 125 volts, 1 amp. d.c. and 4 amp. a.c. on single break, 2 amp. d.c. and 6 amp. a.c. on double break. **Ward Leonard Electric Co.**, Mount Vernon, N. Y.

Midget relays are furnished with a molded bakelite base. All double-pole relays have rubber-insulated lead wires. On double-pole, double-throw relays, contacts carried by the bakelite arm are secured by a spun-over riveting operation that requires no facing and thereby eliminates open-end grain contact.

•

Decade Capacitor

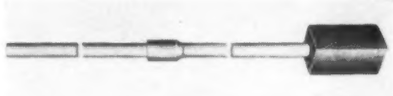
Decade capacitor; ranges, 11.1 mfd. total in 0.01-mfd. steps, and 1.11 mfd. in 0.001-mfd. steps. **Industrial Instruments, Inc.**, Jersey City, N. J.

Suitable for bridge measurements a decade capacitor employs paper or mica dielectric capacitors. It has knobs and dials calibrated directly in capacitance so that reading from left to right totals up the value available at the binding posts. Accuracy is said to be 1 percent.

•

Ground Rod Driver

For installing either hollow or solid ground rods, sectional ground rod driver is slipped over rod to be installed vertically and driven with pile driver action. When first section of pipe touches the ground, it is removed and driving is continued until shore section of pipe touches the ground; then the driver is removed and used as a sledge.

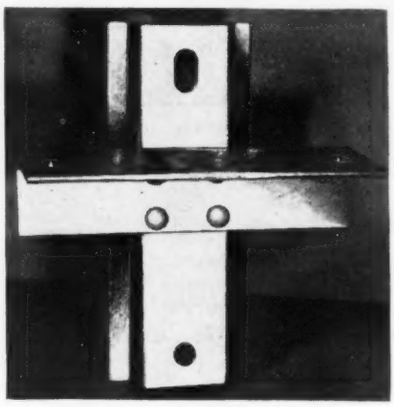


Ground rod driver; ground rod sizes up to 5/8 in. diameter. **A. B. Chance Co.**, Centralia, Mich.

BUYING ELECTRICAL EQUIPMENT?—McGraw-Hill's *Electrical Buyers Reference* is a convenient place to look first for manufacturers' product data, names and addresses.

Brace Gain

A brace gain, made of openhearth steel and galvanized, has been made available to eliminate the expense of gaining wood poles and the necessity for wood or steel



"No. 4291" brace gain: useful on arms up to 10 ft. long. **Locke Insulator Corp.**, Baltimore, Md.

crossarm braces. Impulse strength of the wood circuit is not reduced by any appreciable amount, it is claimed.

•

Resistors

Negative temperature coefficient resistors; maximum wattage ratings range from 0.75 to 3.0 watts; sizes in inches, 5/32 x 3/8, 5/32 x 1/2, 5/32 x 1, and 1/4 x 1. **Keystone Carbon Co.**, Saint Marys, Pa.

Additions to the company's line of resistors are four sizes of round units with metal coated ends, permitting the use of a cartridge or clip method of mounting.

•

Limit Bridge

"No. 618" Percent limit bridge. **Shallcross Mfg. Co.**, Collingdale, Pa.

Multi-tapped resistances with varying unit value can be tested rapidly and accurately, it is claimed, with a new design of resistance measuring instrument. The bridge has mercury wells for attaching a multi-tap resistor and binding posts for connecting a galvanometer and battery. A rotary switch selects the unit of the multi-tap to be tested and at the same time places the proper resistance standard in the circuit.

Grand Champion

A "Grand Champion" horse in the highly trained gaited classes has won his place through proficiency in two general classifications—conformation and performance. We all know about "performance" whether it concerns horses or Pole Line Hardware, but conformation is something vastly different, though closely related.

With horses it is the shape of the head, the contour of body and legs, the placement and carriage of ears, mane and tail. A horse is *born* with it or without it. In hardware it is "design", and must be *put into* the article by someone who *knows*.

Hubbard 4-11-44 Wireholders have "clicked with judges" all over the world. Their design has been approved, tested and checked by "performance" for many years and under all conditions.

If you have not yet used the BLUE RIBBON 4-11-44 Hubbard Wireholder, you are in for a pleasant surprise. Write for a sample to look over and test—and "judge" for yourself.

HUBBARD AND COMPANY
PITTSBURGH . . . OAKLAND CALIFORNIA . . . CHICAGO

Write for Sample to
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6301 Butler St. Pittsburgh, Pa.

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Rutherford, N. J. Rutherford 2-7434 | New Castle, Pa. New Castle 2285 | Pittsburgh, Pa. Atlantic 9798 | Omaha, Nebr. Atlantic 8305

TECHNICAL LITERATURE

NEUTRALIZING TRANSFORMERS—An engineering report by the Joint Subcommittee on Development and Research of Edison Electric Institute and Bell Telephone System describes two types of neutralizing transformers, one developed for use on communication circuits serving power stations, and the other for reducing the effects of low-frequency induction on open-wire telephone lines. Data are given whereby the effectiveness of these transformers can be determined. Copy of Engineering Report No. 44, "Neutralizing Transformers," Publication H-12, may be obtained from Edison Electric Institute, 420 Lexington Ave., New York, N. Y. Price 75 cents to non-members in U.S.A.

COLD FILLING COMPOUND—A 20-page booklet contains characteristics, test data, applications, and installation data of a compound for filling cable joints or terminal boxes. A sketch is included for a straight-through emergency joint for 3-core cable up to 11 kv. This information is made available to maintain electrical service, particularly during hostilities when repairs must be made rapidly. Copy may be obtained from W. T. Henley's Telegraph Works Co., Ltd., G.P.O. Box 249, London, E.C.1, England.

SILVER ALLOY BRAZING—Joint design and the joining process by low temperature brazing with silver alloys are discussed in a publication, "Best Joint Designs for Silver Alloy Brazing," obtainable from Handy & Harman, 82 Fulton Street, New York, N. Y. Some points covered are types of joints, shear depths, applying the alloy, method of heating, and electrical conductivity; these are supplemented with data as well as illustrations on the application of Sil-Fos and Easy Flo, silver alloys.

FUSES—A "Revised Report on Standards for Fuses above 600 Volts" covers all types of fuses whether for indoor or outdoor service. Service conditions, ratings and tests are included, as well as recommended methods for determining the rms value of sinusoidal current wave, and of determining the equivalent steady-state rms current. Copy of the report, publication No. 25, July 1941, is obtainable from American Institute of Electrical Engineers, 33 West 39th St., New York, N. Y.

BIBLIOGRAPHY OF RELAY LITERATURE, 1927–1939. By Relay Subcommittee of A.I.E.E Committee on protective devices. Presents nearly 450 annotated references to world-wide literature on protection, service restoration, test, stability, calculations, instrument transformers and auxiliaries. Prepared in lieu of revision of NELA Relay Handbook of 1931. Published by American Institute of Electrical Engineers. 16 pages. Price (to non-members) 50 cents.

"CATECHISM"—A series of questions and answers provides a working knowledge of electrical phenomena and terminology, listed in a 48-page publication, "Catechism of Electrical Machinery." The new, revised edition begins by explaining electricity and magnetism as utilized in electric generators and motors and discusses important electrical measurements. Principles of a.c. and d.c. generators and motors are presented. Simplified diagrams and tables of practical application are included. Copy of the "Catechism," Bulletin E100C, is available upon request on your business letterhead to Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago, Ill.

SMALL AND NEAT *But* MIGHTY DEPENDABLE *Nicopress*

HERE'S a complete method of splicing and dead-ending distribution lines that will meet your requirements and assure complete satisfaction.

Years of service have proven conclusively that Nicopress Splices are strong, that the conductors will not pull out, and that they have a lasting high conductivity.

And as for Dead-Ending, you just can't beat Nicopress. Both Nicopress Offset and Suspension Dead-Ends are designed to simplify the work and assure strong, trouble-free installations.

A desirable and important feature common to both Nicopress Offset and Suspension Dead-Ends is their ability to withstand the strains of vibration.

The same compact, easy-to-operate Nicopress Tool is used for making line splices and Dead-Ends.

An ever increasing number of Light and Power Companies are standardizing on Nicopress.

Order Nicopress from your Jobber today—

THE NATIONAL TELEPHONE SUPPLY COMPANY

Manufacturer of

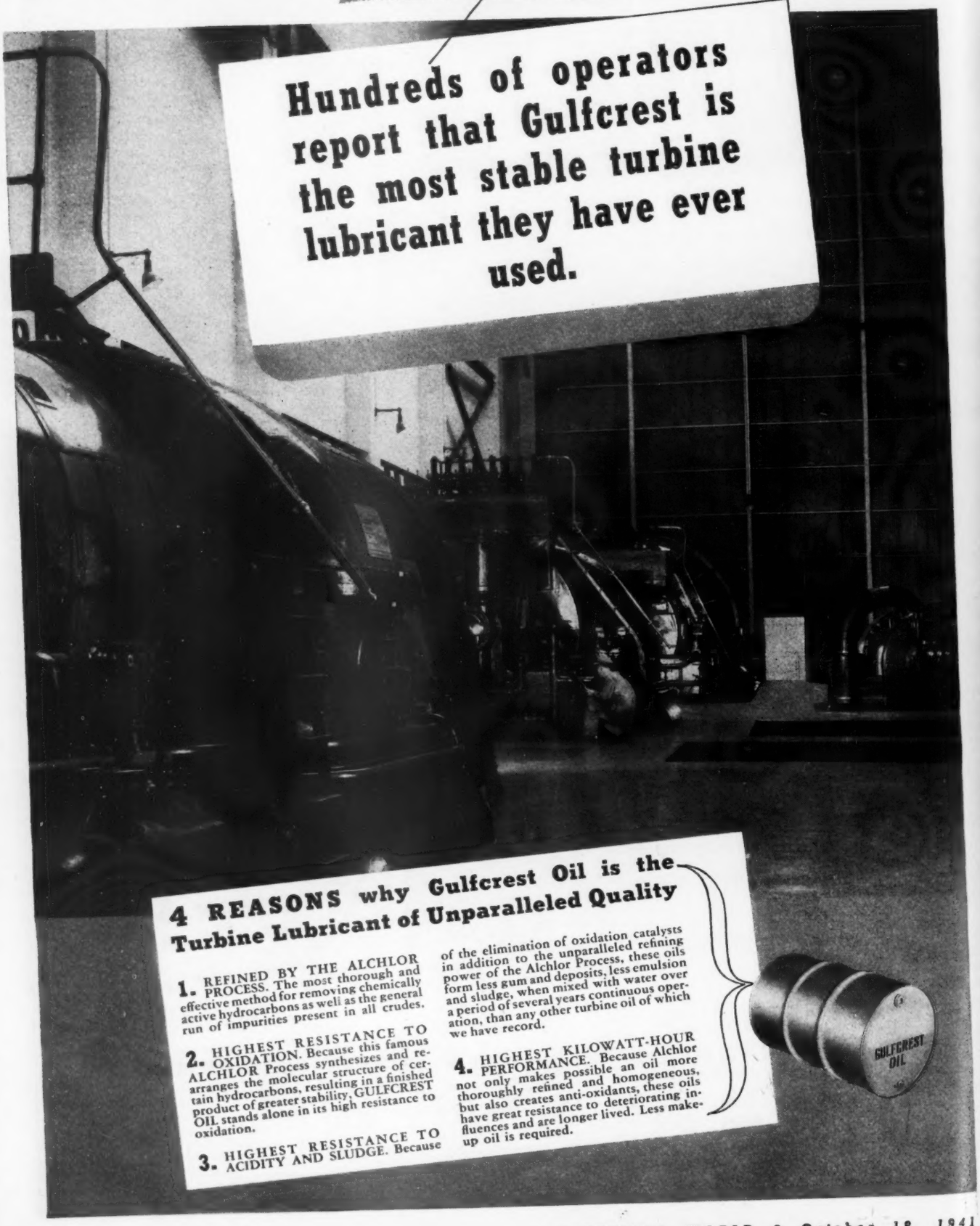
Specialties for Power and Communication Lines

5100 Superior Avenue — **Cleveland, Ohio**

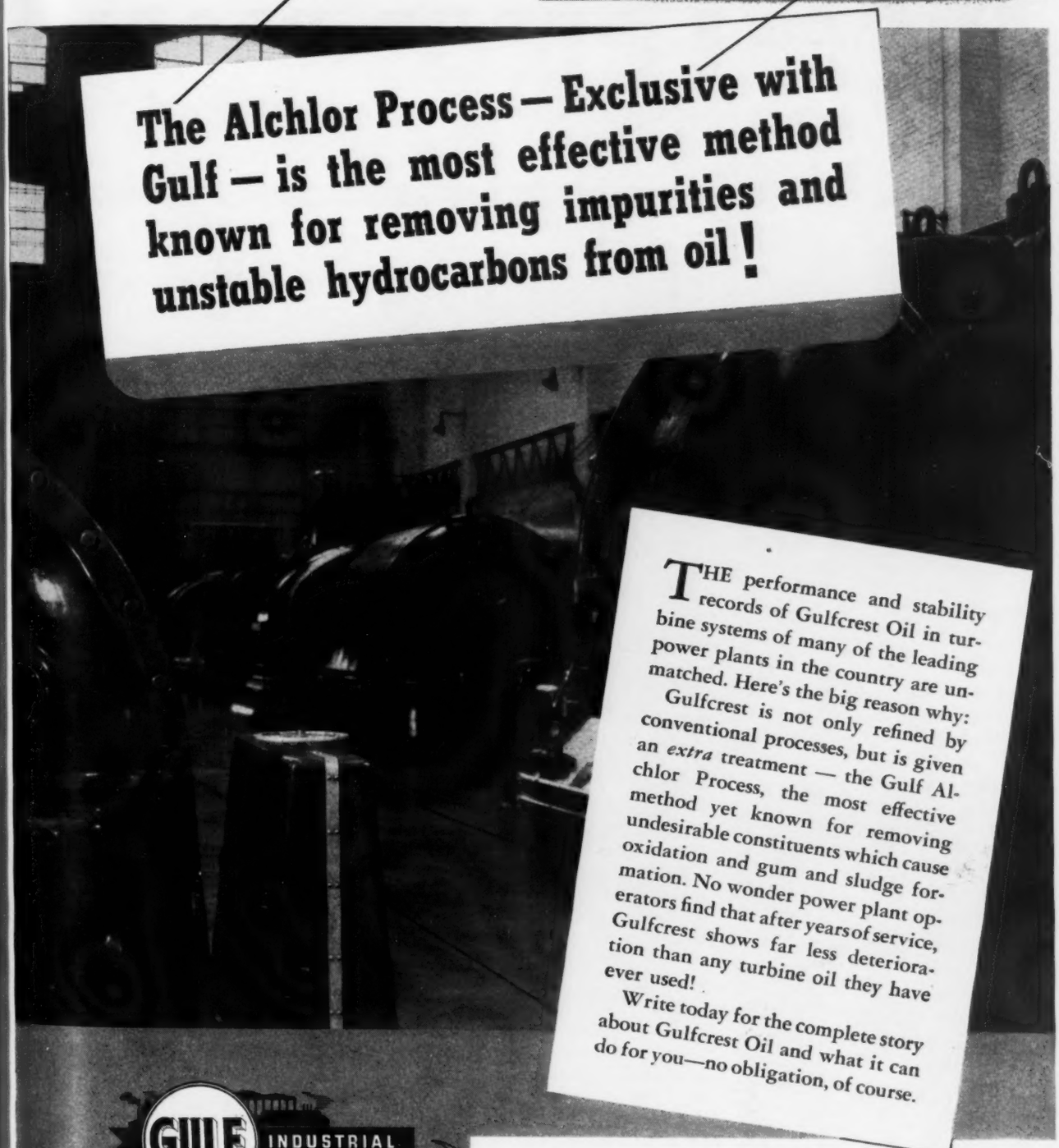
Canadian Mfr.—N. Slater Co., Ltd., Hamilton, Ont.

Export Distributor—INTERNATIONAL STANDARD ELECTRIC CORP., New York, N. Y.

Gulfcrest Stability is due to


Hundreds of operators report that Gulfcrest is the most stable turbine lubricant they have ever used.
4 REASONS why Gulfcrest Oil is the Turbine Lubricant of Unparalleled Quality
1. REFINED BY THE ALCHLOR PROCESS. The most thorough and effective method for removing chemically active hydrocarbons as well as the general run of impurities present in all crudes.
2. HIGHEST RESISTANCE TO OXIDATION. Because this famous ALCHLOR Process synthesizes and rearranges the molecular structure of certain hydrocarbons, resulting in a finished product of greater stability, GULFCREST OIL stands alone in its high resistance to oxidation.
3. HIGHEST RESISTANCE TO ACIDITY AND SLUDGE. Because of the elimination of oxidation catalysts in addition to the unparalleled refining power of the Alchlor Process, these oils form less gum and deposits, less emulsion and sludge, when mixed with water over a period of several years continuous operation, than any other turbine oil of which we have record.
4. HIGHEST KILOWATT-HOUR PERFORMANCE. Because Alchlor not only makes possible an oil more thoroughly refined and homogeneous, but also creates anti-oxidants, these oils have great resistance to deteriorating influences and are longer lived. Less make-up oil is required.
GULFCREST OIL

Alchlor Process "Remove-Ability"



The Alchlor Process — Exclusive with Gulf — is the most effective method known for removing impurities and unstable hydrocarbons from oil!

THE performance and stability records of Gulfcrest Oil in turbine systems of many of the leading power plants in the country are unmatched. Here's the big reason why: Gulfcrest is not only refined by conventional processes, but is given an *extra* treatment — the Gulf Alchlor Process, the most effective method yet known for removing undesirable constituents which cause oxidation and gum and sludge formation. No wonder power plant operators find that after years of service, Gulfcrest shows far less deterioration than any turbine oil they have ever used!

Write today for the complete story about Gulfcrest Oil and what it can do for you—no obligation, of course.

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Please send me my copy—no charge—of the brochure "Gulfcrest Turbine Oil."

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NEWS ABOUT PEOPLE

Johns-Manville Makes Executive Appointments

Appointment of R. F. Orth as manager of Johns-Manville's public utility and electrical department has been announced.

After being graduated from Texas A. & M. College in 1923, Mr. Orth entered the employ of the Western Electric Co. In 1924 he joined the Johns-Manville organization, and since that time has served in various capacities. In 1940 he was made staff manager for J-M transite pipe sales in the west with headquarters at St. Louis, a position which he held until his recent move to New York to take over his present duties.

John A. O'Brien, who was recently elected to the position of vice-president of Johns-Manville Sales Corp.

J. A. O'Brien

(ELECTRICAL WORLD, October 4, page 74), has been general sales manager of the power products and industrial department since 1938. He began his career with Johns-Manville in 1915. In addition to his new executive duties Mr. O'Brien will continue in his position in the power products and industrial department.

R. F. Orth

•

▶ WALTER E. HAWKINSON, treasurer of the Allis-Chalmers Manufacturing Co. since 1936, has been elected to the joint position of secretary-treasurer. He assumes the secretarial duties of William A. Thompson, vice-president and secretary, who resigned recently after forty years of service with the company.

▶ C. M. CARLSON, operating superintendent of the Albert Lea, Minn., territory of Interstate Power Co., has been named to succeed M. E. HALL as manager of the northwestern district. Mr. Hall retired from active service with the company in August. Succeeding Mr. Carlson as operating superintendent at Albert Lea will be JOSEPH KOEVENIG, formerly load dispatcher there.

▶ BROOKS STEVENS, industrial designer, has been retained by the Four Wheel Drive Auto Co., Clintonville, Wis., to restyle and streamline future FWD truck models. A graduate of Cornell University, college of engineering, Mr. Stevens is well-known in the industrial design field.

Personnel Changes Made in Electrical System

Announcement has been made by the Detroit Edison Co. of changes in duties of several members of the electrical system.

George H. Doan, assistant to superintendent, has been given charge of the development and application of adequate and economical construction and operating standards for the system. He continues in charge of communication systems, trouble reports, cable testing and fault location.

Samuel Fraser has been appointed assistant to the superintendent of the electrical system, reporting directly to the superintendent. In this capacity he has general responsibility for the operation of the entire electrical system.

Edward R. Moore was made budget engineer. He is responsible for system budgets, adequacy of major equipment stocks and cable commitments, projects priorities and cost control of new projects.

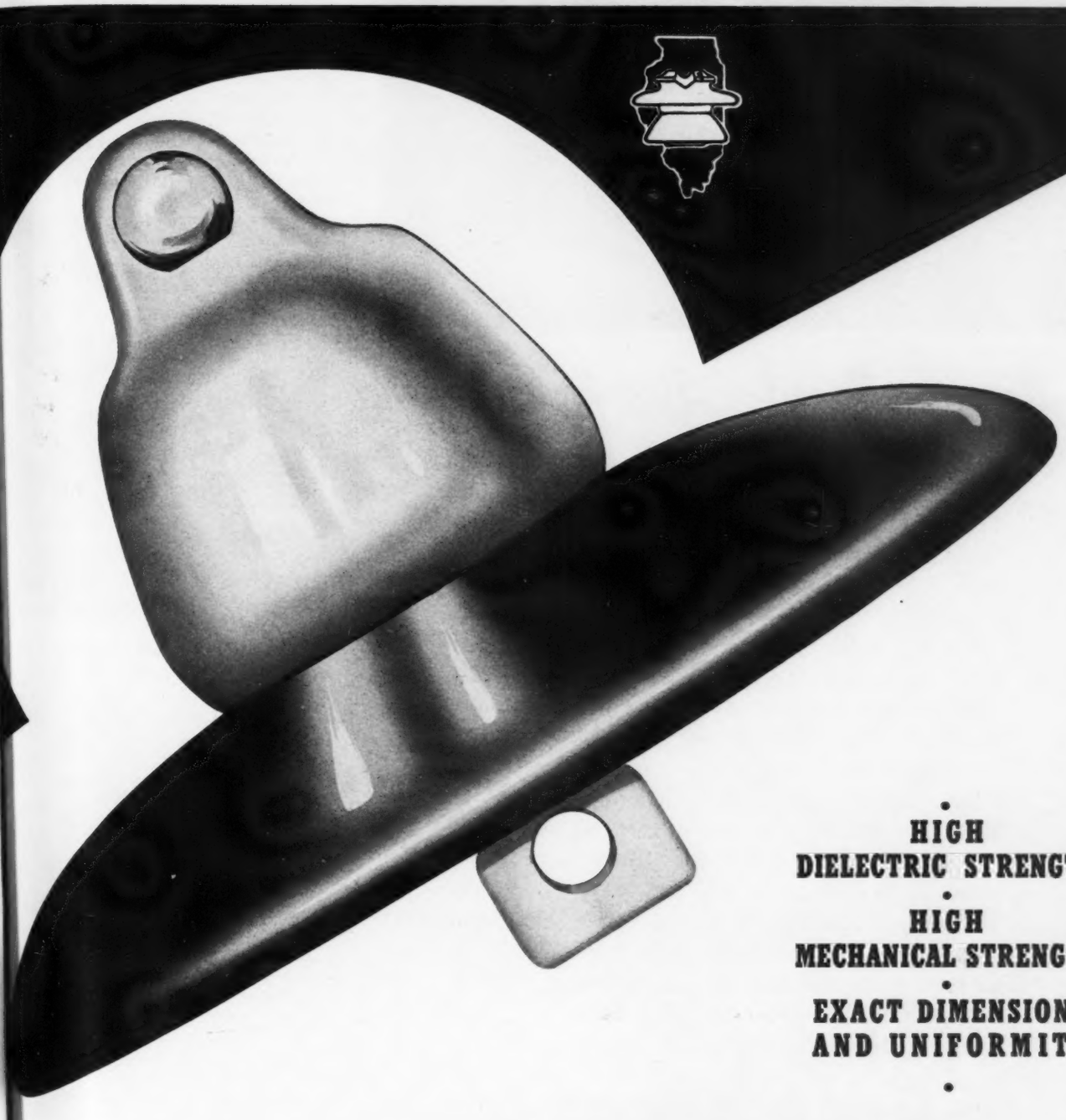
F. Clifford Pohl was appointed superintendent of substations, in charge of all substations and switching stations for which the substation department is responsible. Casper F. Ries has been appointed assistant to superintendent of substations. Mr. Ries will continue as department supervisor of training.

•

▶ CHARLES I. MAUST, assistant engineer, Public Service Electric & Gas Co., has joined Ebasco Services, Inc., as assistant engineer.

▶ O. A. SODERBERG has been transferred from the Philadelphia district office of the Combustion Engineering Co., Inc., to the managership of the Detroit district office. This position was left vacant since W. J. Vogel was transferred to New York as executive engineer. Mr.

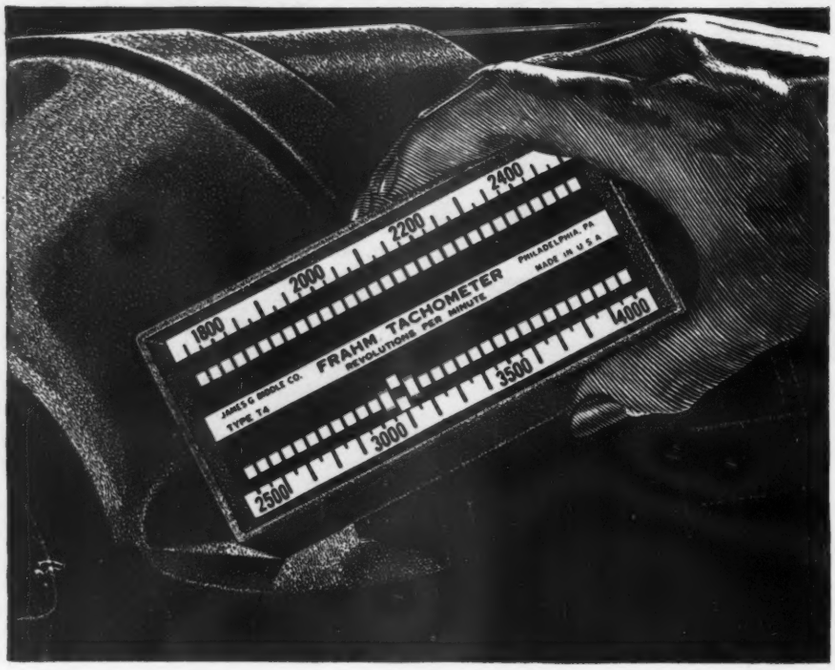
BALANCED DESIGN



- HIGH DIELECTRIC STRENGTH
- HIGH MECHANICAL STRENGTH
- EXACT DIMENSIONS AND UNIFORMITY

ILLINOIS
PORCELAIN LINE INSULATORS

INOIS ELECTRIC PORCELAIN CO. MACOMB. ILLINOIS



Measure Speed — Simply by Touch

Consider the advantages of a Portable Hand Tachometer that does not even "see" the rotating shaft, that has no wearing parts or pointer, that requires no belts, gears or electrical connections and that cannot lose its calibration through lack of oil or over-speeding.

Simply hold the Frahm Tachometer against some stationary part of the machine under test. Almost immediately one of the calibrated reeds begins to vibrate and the corresponding point on the scale shows the speed.

It works by mechanical resonance. Slight vibration of the machine passes into the instrument through the point of contact and the particular reed which is in tune goes into responsive vibration.

This unique device may help to solve your speed-measuring and vibration problems. Made for both hand use and for permanent mounting, ranges from 900 up to 30,000 r. p. m.

Write for Bulletin 1590W

JAMES G. BIDDLE CO.

1211-13 Arch Street, Philadelphia, Pa.

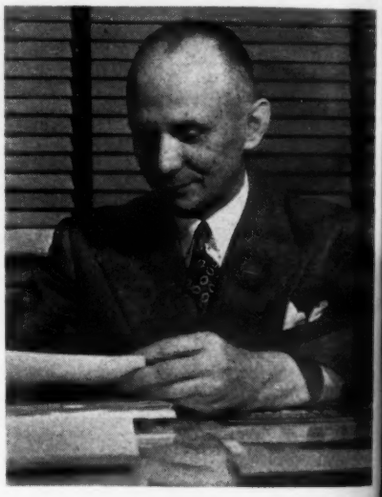
"FRAHM" Vibrating Reed TACHOMETER

Soderberg was identified with the Winchester Arms Co., Griscom-Russell Co. and the Sun Oil Co., before affiliating himself with the Combustion Engineering Co.

•

Blaw-Knox Co. Appoints E. A. Wert Vice-President

Edwin A. Wert has been appointed vice-president of the Blaw-Knox Co. in charge of engineering and sales of its power piping division. The new divisional executive, taking the position held until recently by S. J. Horrell, has been a consultant for the company for a number of years and goes to Blaw-Knox from the Detroit Edison



Co., where he has been engaged in an engineering and design capacity for eighteen years.

Mr. Wert is well known for his work on piping design and recently developed, in behalf of Blaw-Knox Co., simplified formulas for determining the stresses in power piping systems. He is the inventor of the Blaw-Knox functional spring hangers and vibration eliminators for high-pressure, high-temperature piping systems.

An alumnus of the University of California, he is a member of the American Society of Mechanical Engineers and has served as a lecturer at the Detroit Institute of Technology.

•

▶B. W. BURTON, formerly district superintendent of the Georgia Power Co. at Albany, Ga., has been transferred to Columbus as district superintendent. A. C. DELAMAR, formerly connected with the Columbus district, succeeds Mr. Burton in Albany.

▶JOHN W. WALKER, formerly chief engineer of the Northern Indiana Power Co. and of the Central Indiana Power Co., before their consolidation

VITAL QUESTIONS & ANSWERS ON FLUORESCENT LIGHTING. by HYGRADE

Q. How can you, in planning fluorescent lighting installations, select a manufacturer *thoroughly* qualified to handle the *entire* job?

A. Look at the record. It shows three things: first, HYGRADE pioneered in the fluorescent fixture business; second, HYGRADE has *paced the field*, has introduced the *best* things *first*, and in cases where available parts and accessories failed to meet exacting standards, has actually designed and made these parts; third, HYGRADE supplies *everything* in fluorescent *at its finest—for every kind of installation!*

Q. How can you be sure of securing top fluorescent light output and efficiency at all times?

A. The answer to this is indicated in exclusive HYGRADE patents filed in Washington. These patents describe the *superior coating* used in HYGRADE Fluorescent Lamps—assuring you *even distribution of light* along the entire length of each lamp—*more pleasing appearance — standardized colors—finer all-round performance!*

Q. How can you be sure of specifying fluorescent lighting equipment that will *stand up?*

A. Find out how far various manufacturers go in backing it up. HYGRADE *goes all the way—designs, engineers, makes, assembles, sells, ships,* and GUARANTEES every unit!

Q. How can you be sure that installations will be completed swiftly and inexpensively?

A. Check with anyone who has specified HYGRADE. He will tell you that HYGRADE'S policy of making, assembling, and shipping fixtures complete *cuts breakage in transit—speeds installation—insures a better job!*

Q. How can you get complete information on HYGRADE Fluorescent Lighting equipment in a quick-reading easy-reference form?

A. ***Write us today*** for a free, file-size kit—containing catalogue, prices, specification sheets.

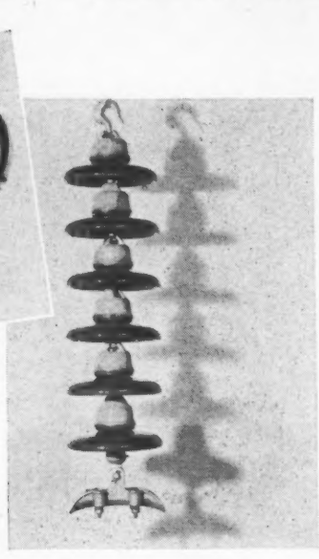
HYGRADE SYLVANIA CORPORATION
Dep't EW2, Salem, Mass. Est. 1901

Also makers of HYGRADE Incandescent Lamps and Sylvania Radio Tubes.

Brilliantly lighted new showroom, Consolidated Edison Company, New York, N. Y.

Veteran Craftsmen Made Them Both

"EARLY BIRDS"



1941

A lot of juice has gone over the wires since those "Early Birds" shown above were the last word in high tension insulators. But every improvement in utility service has found Victor ready with insulators to meet new demands. The same specialists who designed and fabricated the porcelain of a generation back are right here at Victor applying their long experience to the production of our latest types. This "old hand" expertness results in uniform quality and safe performance of every Victor Insulator . . . Glad to quote on your requirements.

V *the Mark of a* **GOOD** *Insulator*

VICTOR INSULATORS, INC.
VICTOR, NEW YORK

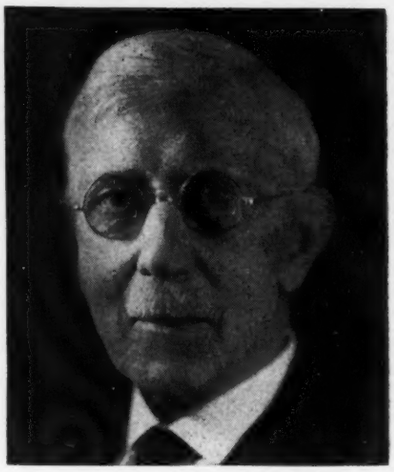
into the recently organized Public Service Co. of Indiana, Inc., has been appointed assistant to G. J. Oglebay, vice-president of the new company.

OBITUARY

C. L. Clarke

Charles L. Clarke, oldest surviving former associate of Thomas A. Edison, died at Newton, Mass., on October 9, at the age of 88. Mr. Clarke was the last of the charter members of the American Institute of Electrical Engineers, founded in 1884, and served the Edison Pioneers as president in 1925.

He entered the laboratory of Thomas



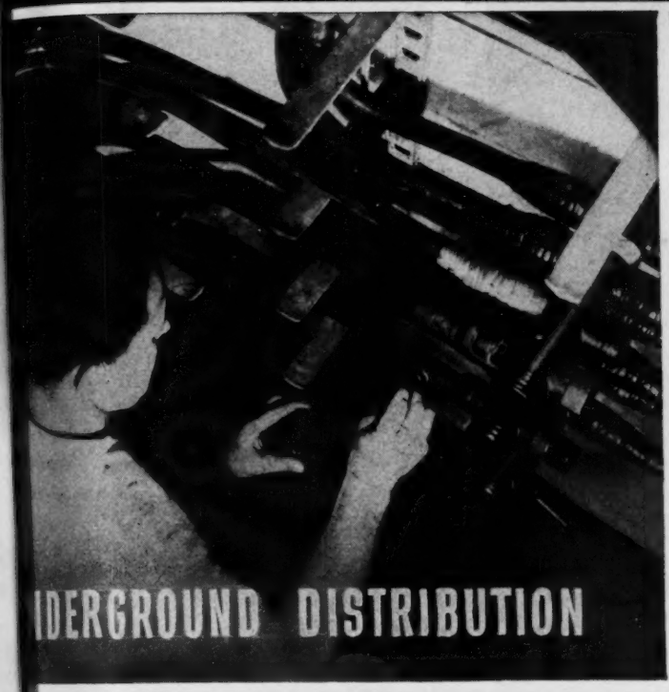
A. Edison at Menlo Park, N. J., as an assistant in 1880. The following year Mr. Edison appointed him chief engineer of the Edison Electric Light Co., in which capacity he had charge of all the mechanical engineering for the pioneer system.

Mr. Clarke joined the staff of the General Electric Co. in Schenectady, N. Y., in 1913, serving successively as consulting engineer and research specialist until his retirement in 1931. He was born in Portland, Me., on April 16, 1853, and received M.S. and C.E. degrees from Bowdoin in 1879 and 1880, respectively.

•

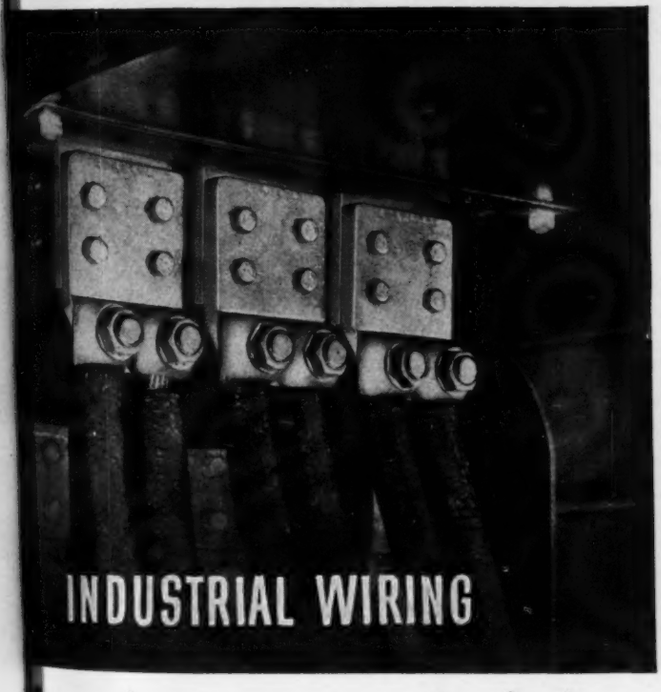
▶ JOHN M. COSTELLO, vice-president Central New York Power Corp., Syracuse, N. Y., died on August 15, in his fiftieth year. Mr. Costello joined the Niagara, Lockport & Ontario Power Co. in 1911. He served as district manager of the company, eastern division from 1925 to 1928, and executive manager of the eastern territory from 1928 to 1930. He was elected assistant vice-president of the Buffalo, Niagara & Eastern Power Corp. early in 1930 and later that year was transferred to Syracuse as general manager of the Syracuse Lighting Co., Inc. Subsequently

)R CONNECTORS CONSULT THE SPECIALIST— *Burndy*



IDERGROUND DISTRIBUTION

OVERHEAD DISTRIBUTION



INDUSTRIAL WIRING

OUTDOOR SUBSTATIONS

ur business is to help you hook up Your business

verhead, underground, in transmission and distribution, connectors are a vital link in ur electrical service chain . . . so connectors ust be *dependable*, designed to do their jobs. Years of research in connection needs and hnical performance have made Burndy engineers "Connector Specialists" and Burndy connectors the standard for quality. Small wonder utility men demand Burndy Connectors.

The Burndy Engineering Company supplies connectors for every application with cable, tube, bar, rod and wire. You will find the catalog a valuable aid in solving your connection problems. Request your copy, today.

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Use this hammer...

(the CONTINENTAL-DIAMOND Laboratory)

to help solve that new "What Material?" problem . . . possibly also that unsolved old problem . . . it may be electrical, mechanical, or structural . . . involving replacement of weighty, corrosive, costly or hard to get metals with one of the varied and versatile C-D Products:

to INSULATE ELECTRICALLY.
to STRENGTHEN.
to LIGHTEN WEIGHT.
to PREVENT CORROSION.
to ABSORB VIBRATION.
to SPEED-UP PRODUCTION.
to INCREASE PERFORMANCE EFFICIENCY.

Our booklet "What Material?" will be of interest to your designers . . . engineers . . . production men. Ask for GF 12

Continental-Diamond FIBRE COMPANY

"Manufacturers of Laminated Plastics Since 1911"

NEWARK • DELAWARE

he became a vice-president of Syracuse Lighting. It was in 1937 that he was named vice-president of the Central New York Power Corp.

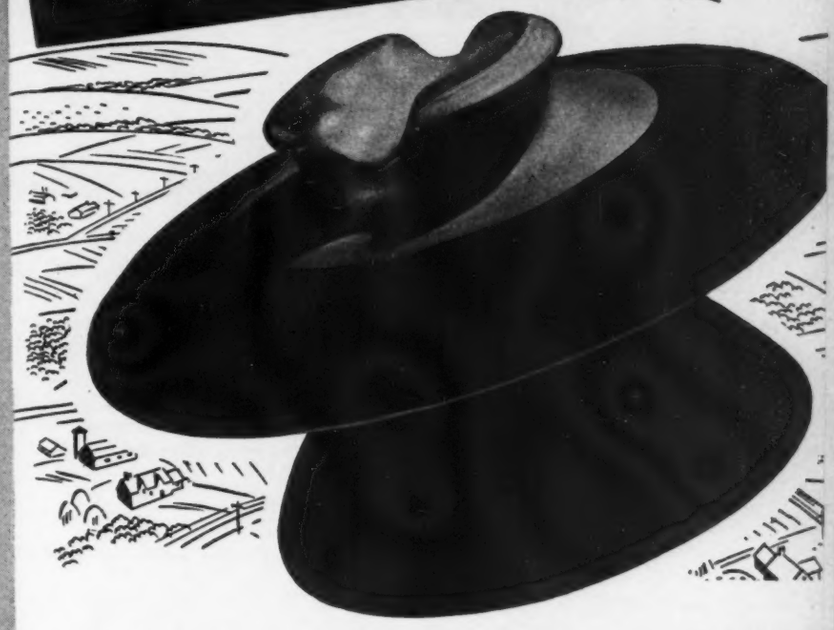
► LESLIE N. CRICHTON, an electrical engineer associated with the plant of the Westinghouse Electric & Manufacturing Co. in Newark since 1927, died on September 6 at his home in Livingston, N. J., after a brief illness. He was 56 years old. Mr. Crichton was born in Parsons, Kan. He was graduated from the University of Missouri in 1906 and became head of the research laboratory of the Telluride Power Co. at Olmstead, Utah. He joined the Westinghouse company in 1916 and directed its Pittsburgh research laboratory devoted to relay problems. He was transferred to Newark in 1927.

► G. A. DAVIES, formerly superintendent of the power plant of Shawinigan Water & Power Co., at Shawinigan Falls, Que., died in Montreal on September 12, in his fifty-second year. Mr. Davies was born in Liverpool and came to Canada in 1906.

► MILLER LASH, president of the Brazilian Traction, Light & Power Co. and well known lawyer and financier, died at his home in Toronto, at the age of 68. Mr. Lash was a native of Toronto and a graduate of the University of Toronto. He was also a vice-president of Barcelona Traction, Light & Power Co. and chairman of the board of directors of Mexican Light & Power Co. and Mexican Tramways Co.

► EMIL LEONARZ, director-general Compagnia Fundidora de Fierro y Acero de Monterey S. A., Monterey, Mexico, died on July 24. Some years ago Mr. Leonarz was associated with Schuckert & Co. (later Siemens-Schuckert & Co.), Berlin and Nuremberg, Germany, working on power plant design and erection, and later on technical calculations for alternating-current and polyphase generators He went to Mexico in 1905 as chief engineer of distribution for the Mexican Light & Power Co., Mexico City. From 1909 to 1911 he was consulting engineer for the company and in 1911 became manager of the Monterey Railway, Light & Power Co. From 1915 to 1918 he practiced consulting engineering, and then became professor of electrical engineering at the Practical School of Mechanical and Electrical Engineering, Mexico City. In 1922 he was appointed assistant manager of the Compagnia Fundidora de Fierro y Acero de Monterey S. A., later becoming managing director. He retired from that position in 1940, but continued to serve in a consulting capacity and as a member of the board of directors. He was a fellow of the A.I.E.E.

R. I. P.
High Voltage Pin Types



For Low-Cost, Noiseless Transmission Lines Up To 66 K

To transmission line engineers faced with new line constructi
. . . or increasing voltages on existing lines . . . R.I.P. high volta
pin type insulators offer important savings.

On new single circuit lines, pin type insulators require less p
height—only *one* and *smaller* crossarm. Third phase goes
pole top pin. Result—lower pole cost . . . less labor . . . less ha
ware. For raising present line voltages, pin types do away wi
need for new and taller poles or new crossarms. Just take do
present insulators and install the new ones.

R.I.P. pin type insulators eliminate the objectionable radio no
formerly inherent with pin type construction . . . make availa
lower construction costs . . . provide rapidity of changeover. W
not take advantage of them? Two modern factories—Derry, P
and Emeryville, Cal. Westinghouse Electric & Mfg. Compa
E. Pittsburgh, Pa., Dept. 7-N. J-0

R.I.P. Glaze Permanently Eliminates Insulator-Generated Nois

R. I. P. (radio-interference-proof) treatment applied to insulator surfaces is guaranteed by Westinghouse to eliminate insulator-generated radio interference. The metallic oxide glaze becomes an integral part of the insulator during the normal firing process. It never wears off—never needs servicing.

NOISY—Capacity currents jump across the tiny air gaps between conductor and insulator surfaces. These capacity arcs act as miniature radio stations. Result—radio interference.

QUIET—Metallic (I glaze furnishes a lo sistance contact. R capacity current through contacts, *b across air gaps.* . . . . no radio interf

INCREASING LINE VOLTAGES DOESN'T NEED TO BE EXPENSIVE

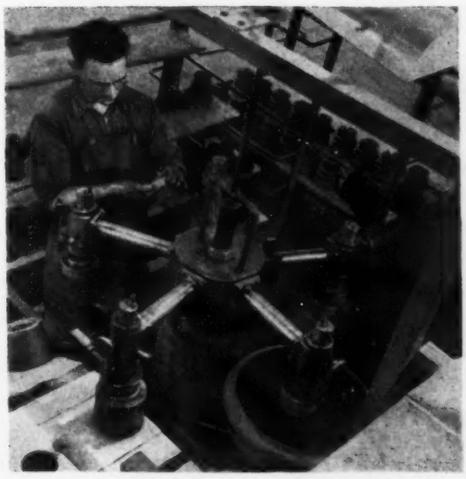
AN EXAMPLE OF HOW A LINE WAS RE-BUILT TO CARRY HIGHER VOLTAGES, NOISELESSLY, AND AT A MINIMUM OF EXPENSE WITH R.I.P. PIN TYPE INSULATORS

Yesterday

A 33 kv single circuit line, built originally under closely designed clearances, was equipped with suspension type insulators. Problem: to raise the line voltage to 66 kv. Using suspension insulators, this meant new poles and new crossarms to secure necessary clearances—an expensive operation.

Today

With Westinghouse R.I.P. pin type insulators, the changeover is much less expensive. The same poles are used and the necessary ground clearance gained by raising the crossarm. The third phase is placed on a pole top pin. R.I.P. eliminates the possibility of insulator-generated radio interference.



PRECISION R.I.P. GLAZING

Only Westinghouse gives you this automatic R.I.P. glazing . . . an extra precaution to insure uniformity of the radio-interference-proof coating on every insulator. The machine arm dips an accurately controlled area of each insulator into the vat of metallic oxide glaze . . . always just the right amount. No chance of human error. Another "extra" you pay no more for when you specify Westinghouse Porcelain!

Westinghouse Porcelain

MANUFACTURING-MARKETS

Electric Furnaces in Coast Expansion

Nearly one-seventh of the 1,865,000 tons of steel expansion which OPM expects to push on the West Coast as part of the 10,000,000-ton expansion program approved by SPAB will be electric furnace operation. Of the 243,200 tons of ingot planned from electric-fired mills, 151,200 tons is to be located in California, 32,000 tons in Washington and 60,000 tons in Oregon.

Detailed company proposals made to OPM for expansion of steel output lists 60,000 tons of electric ingot at the Bethlehem Steel Co. plant in Los Angeles, 7,200 tons at the Columbia Steel Co. plant in Pittsburg, Cal., and 84,000 tons at the Niles, Cal., works of Pacific States Steel Co. Northwest Steel Rolling Mills has offered to build the electric furnace in Seattle and Oregon Electric Steel Rolling Mills, Inc., the Oregon tonnage.

OPM has before it proposals from steel companies in other sections to build nearly 12,000,000 additional tons of ingot capacity, but the amount of electric furnace operation has not been made public.

•

Secondary Network for New Navy Plant

A secondary network system utilizing 37 300-kva. Westinghouse air-cooled transformers will supply the Navy's new ordnance plant near Canton, Ohio. Risk of sabotage will be minimized and erection and maintenance simplified by use of the network.

Incoming power from Ohio Power Co. is distributed at 13.8 kv. to the air-cooled transformers on platforms above the floor. As a safeguard against failure in one line, two separate primary feeders run to the transformers, each large enough to carry the entire load. Under normal operating conditions the 300-kva. transformers are supplied at half the carrying capacity of the feeders. If a network transformer or part of an entire circuit fail, protectors and current limiters will automatically isolate the unit or the circuit from the system and remaining transformers will share the total plant load.

•

Lets Power Line Contract

A $691,212 contract for conductor and accessories on the No. 2 Midway-Coulee power line was awarded recently by the Bonneville Power Administration to the Anaconda Wire & Cable Co.

•

Motors, Generators August Orders Drop

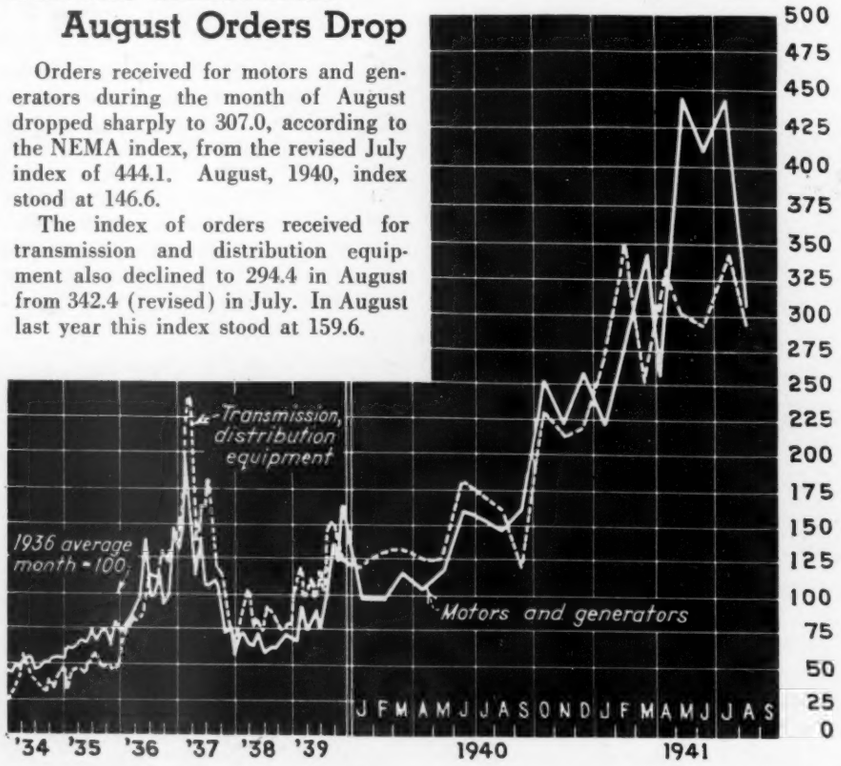
Orders received for motors and generators during the month of August dropped sharply to 307.0, according to the NEMA index, from the revised July index of 444.1. August, 1940, index stood at 146.6.

The index of orders received for transmission and distribution equipment also declined to 294.4 in August from 342.4 (revised) in July. In August last year this index stood at 159.6.

GRDA Makes Award on Generating Unit

Grand River Dam Authority, Vinita, Okla., has awarded a contract to Westinghouse Electric & Manufacturing Co. for an electric generator and to Allis-Chalmers Manufacturing Co. for a hydraulic turbine, with governor and accessories, for installation in hydro-electric generating station on Grand River at Pensacola, Okla., making the fifth unit at the plant.

The authority has received low bid from A. S. Schulman Electric Co., Chicago, Ill., at $264,898 for construction of a new 66,000-volt transmission line from generating station at Pensacola to point on Kansas-Oklahoma state line, vicinity of Miami, Okla., about 47 miles.



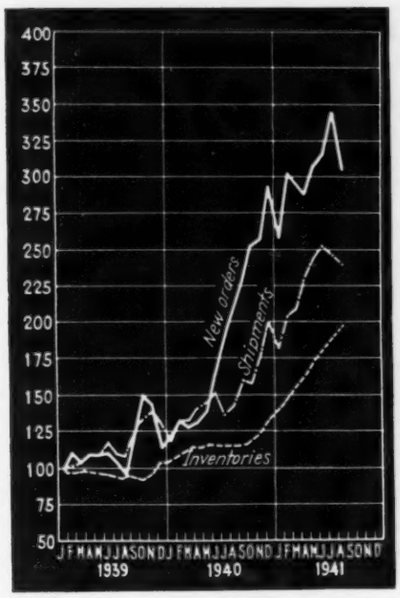
NEMA INDEX, value of orders received for motors (large d.c. polyphase synchronous) and generators (engine, belt-driven); also for transmission and distribution equipment

including dismantling of about 10 miles of existing transmission line between generating plant and Vinita.

•

New Orders Received in August Drop

The current defense period has been characterized by an extraordinary rise in total output, with armament production in the first phase being largely superimposed on virtually complete satisfaction of expanded consumer wants. Although additional facilities and an increased supply of basic materials will provide the means for some further increase, total output has now passed through the major expansion phase and war materials will account for an increasing proportion of future production.



ELECTRICAL MACHINERY INDICES of Bureau of Foreign and Domestic Commerce

Index of value of new orders received by electrical machinery manufacturers in August, according to the Department of Commerce, was 305, against 339 in July.

Index of manufacturers' shipments was 238 in August, compared with 246 in July and 143 in August, 1940. For inventories, the index was 196.3, against 188.8 in July and 115.5 in August, 1940.

New York Metal Prices

	Oct. 14, '41 Cents per Pound	Oct. 8, '41 Cents per Pound
Copper electrolytic	12.00*	12.00*
Lead, A. S. & R. Price	5.85	5.85
Antimony	14.00	14.00
Nickel, Ingot	35.00	35.00
Zinc Spots	8.25	7.64
Tin, Straits	52.00	52.00
Aluminum, 99 percent	15.00	15.00

* Delivery Connecticut Valley.

GO MULTI-BREAKER

★ WITH AUTOMATIC PROTECTION . . .

★ NOW AVAILABLE IN A LOWER PRICE RANGE . . .

TRUMBULL

AUTOMATIC PROTECTION

SERVICE RESTORED BY TWIST OF HANDLE

NOTHING TO RENEW

NEW Industrial Type M-1 and M-2

MULTI-BREAKERS

for LIGHT and POWER SERVICE

● Now you can offer industrial and commercial users all the advantages of famous Trumbull Multi-Breaker protection for applications requiring equipment rated at 230 Volts (AC, only) 15 to 100 amps.

These new Type M-1 and M-2 Industrial Multi-Breakers, while low in price provide complete, automatic protection against short circuit and overload. They have BOTH accurately calibrated, non-tamperable thermal-relay, time-delay trip for small overloads, and instant magnetic trip for short circuit or high overload.

Visual indication of trip is given by window target on front of box. Reset after trip by a turn of the handle . . . nothing to replace or renew. Write for new Trumbullaid Circular No. 433.

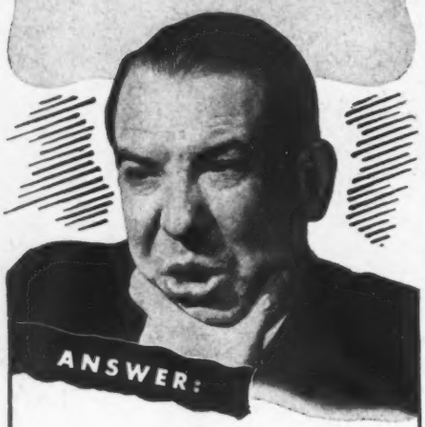
THE TRUMBULL ELEC. MFG. CO. PLAINVILLE CONN. U.S.A.

KEEP *Alert* ELECTRICALLY use your TRUMBULLAIDS

NEW YORK - PHILADELPHIA - BOSTON - CHICAGO - DETROIT - NORWOOD, O. - ATLANTA - NASHVILLE - LOS ANGELES - SAN FRANCISCO - SEATTLE

PROBLEM:

WHERE CAN I GET FLUORESCENT LIGHTING THAT WON'T BE OUT-OF-DATE IN A FEW YEARS?



ANSWER:

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(Trade Mark)

The trade mark "LINOLITE" identifies Fluorescent equipment which is *Engineered for Performance* by Barkon-Frink, the pioneers in gaseous tube lighting. When you specify LINOLITE for your Fluorescent installation you are assured of the *long-term satisfaction* of a sound investment backed by Frink's *complete* lighting service and 84-year record of experience.

New 24 Page illustrated brochure contains important fluorescent lighting data, photos of typical installations and valuable information on correct types of fixtures. It helps you avoid costly and unfortunate mistakes. Mail the coupon today for your copy.

THE FRINK CORPORATION
Bridge Plaza South, Long Island City, N. Y.

Please send me your new brochure on "The Ultimate in Fluorescent Lighting." EW-10

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Field Reports on Business

Industrial activity continues at high levels, with all-out production for defense gaining momentum. It is predicted that production of purely civilian goods will be cut to a greater extent than is now indicated. Unemployment in non-defense industries remains a problem. Retail trade is still booming.

CHICAGO

With all-out production for defense gaining momentum each week, industrial activity continues at high levels over all. Among the numerous small manufacturers in this district, however, the situation grows more critical. Just how great the casualties among these so-called non-defense industries will be depends largely on how rapidly adjustments can be made in widening the distribution of defense contracts. The outlook is not encouraging, for it appears almost certain that many shutdowns and unemployment are bound to occur before corrective methods can be effectively applied.

Retail trade continues to boom and wholesalers report record demand for holiday merchandise. A record Christmas buying season is expected throughout the Middle West. Mail order houses also report record sales volumes.

Orders for electrical equipment appear to be leveling off somewhat. Of 32 manufacturers reporting September sales to the Electric Association, seventeen showed increases over August, while 29 had gains over September, 1940. Only one of the wholesalers reporting showed a decrease from August and 100 percent were ahead of a year ago.

Defense contracts placed in this area last week declined sharply. Orders for electrical equipment included Kohler Co., generator sets, $36,517; Burgess Battery Co., batteries, $49,592; Adams & Westlake Co., lamp assemblies, 20,745; Caterpillar Tractor Co., generating units, $25,122. Bids were asked on 30,000 ft. No. 10, 600-volt, lead-sheathed cable.

PACIFIC COAST

Western retailers report considerably decreased sales during the past fortnight of the excise tax, not only from purchases which anticipated it but also from confusion over its application.

Recent machinery awards include $279,700 to Allis-Chalmers, $421,590 to General Electric and $607,875 to Westinghouse, all for transformers for Shasta plant of Central Valley project; a carload of copper strand for Bonneville and three carloads steel strand to Southern Pacific; three 25,000-kva. generators, value $975,800, to General Electric for Keswick plant.

Recent electrical material ordered for industrial use includes six 333-kva. transformers, value $10,000, for steel pipe plant; $21,000 arc-welding equipment for Honolulu and $16,000 welding sets and cable for a magnesium plant, and a 65-ton Diesel-electric locomotive for a cement plant. In the Eugene, Ore., area there are to be built 334 miles of transmission and distribution lines tieing in with the Bonneville System.

New major governmental awards and appropriations cover $15,720,000 additional for Pearl Harbor on a cost-plus fixed-fee basis, for power plant and additional facilities; $6,500,000 for Army Air Corps depot at Roswell, N. M., and $5,000,000 additional for Army supply deport at Oakland.

Pacific Gas & Electric has bought four 750-kv. step-voltage regulators, value $50,000; an equal amount of switchgear equipment, and 120 distributing transformers, costing $35,000, for its central stock.

NEW ENGLAND

The expansion of naval repair and construction facilities in Boston involving an expenditure of $14,000,000 ordered last week by the Navy Department includes appropriations which will require buying a considerable amount of electrical and mechanical equipment. A total of $11,480,000 will be spent in South Boston, where shop buildings, power and storage facilities and a 250-ton floating crane will be installed.

Lynn Gas & Electric has purchased a B&W boiler rated 210,000 lb. per hour steam at 400 p.s.i. Stone & Webster Engineering Corp. is the constructor, Taunton (Mass.) municipal Lighting Department is installing several network vaults.

Small arms manufacturers in this district are operating at peak capacity. New England shoe and textile plants are busy on large government orders. Precision tool and machine tool builders have encouraging back-logs ahead for steady plant operation during the remainder of the year. Defense equipment orders continue to be well spread as to kind and amount. Yale & Towne Manufacturing Co. has sold $113,125 in electric crane trucks to the government. Landers, Frary & Clark has received an order for fuses totaling $860,000, and Collyer Insulated Wire & Cable Co. has been awarded an electric cable order amounting to $46,528.

NEW YORK

Engineering construction awards for the week, $78,661,000, are 30 percent lower than a week ago and 7 percent below the volume for the corresponding 1940 week as reported by *Engineering News-Record* on October 9. The sharp decline in federal work—54 percent under the preceding week and 15 percent under last year—coupled with a decreased private volume, is responsible for the lower award figure. The week's awards brought 1941 construction to $5,034,245,000, an 88 percent gain over total for 41-week period last year.

Builders in the New York district, who already had been forced to curtail operations because of difficulty in getting deliveries on some basic materials, were dismayed at the sweeping ruling of the Supply Priorities and Allocations Board, forbidding the starting of any public or private construction work except projects essential to national defense or for public health and safety.

Business activity in the Pittsburgh district in the second week in October increased, the seasonally adjusted index of general business activity rising to 146.2 percent of the 1923-25 average.

OPA has announced extensive revision of the copper scrap schedule, effective October 17, placing ceiling prices on a shipping point instead of a delivered basis, allowing quantity differentials to dealers and establishing premiums for "briquetting" and other special services.

Housing Development Planned by Revere

Claiming that even in the midst of the present emergency American business must think of the future, C. Donald Dallas, president of Revere Copper & Brass Inc., has announced that his company is embarking on a national campaign to keep the public informed of trends and improvements in housing development. The object, Mr. Dallas explained, is to help stimulate for the future a purchasing power built around housing and home furnishing which will help to take up the industrial and labor slack when defense orders taper off.

"Today, with factories working extra shifts around the clock to meet defense orders and strictly rationed non-defense requirements," Mr. Dallas said, "the most embarrassing event in the life of a salesman is to receive an order.

"No one believes that this situation will last. The stream of supplies we have promised to the democracies must sooner or later determine the issue of the war. Then, unless we have planned ahead, we shall once more be face to face with the evils of unemployment of men and industry. Our company believes that it is essential to prepare for the future without diminishing our present defense effort."

•

Littelfuse to Open New Plant in California

Opening of a new plant at El Monte, Calif., signalizes the expansion of Littelfuse, Inc., Chicago. The California plant supplements the Littelfuse factory in Chicago, excess demands on which have made necessary a large increase of production facilities as rapidly as possible. The California plant will be in full operation November 1. The new plant, with 21,000 sq.ft. of floor space, will add about 200 employees to Littelfuse's roll.

Under the management of President Edward V. Sundt and Secretary-Treasurer Thomas M. Blake, the California plant will operate in complete conjunction with the Chicago plant.

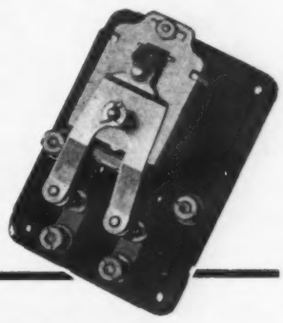
•

Appoints New Sales Agent

Roller-Smith Co., Bethlehem, Pa., has appointed the Electrical Jobber Equipment Co., 501 Fourth Avenue, South, Minneapolis, Minn., its sales agent for the states of Minnesota, North Dakota, South Dakota and that part of Wisconsin west of a line drawn between La Crosse and Ashland.

AT SPECTACULAR TWIN BRANCH

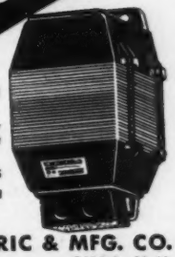
OUTSTANDING engineering progress as exemplified in the spectacular Twin Branch development of the American Gas & Electric Company not only calls for executive vision and engineering skill of the highest order; equally important, it demands painstaking selection of equipment of unquestioned dependability. Thus, it is with pride that we point to the use of Dunco Relays for certain special uses throughout this vast plant—in power transfer units, in interlocking devices, in alarm systems and in various other applications. There is no better evidence that Dunco walks hand in hand with engineering leadership — *because Dunco means dependability* — and because Dunco is well equipped to supply special units for practically any need.



DUNCO RELAYS AND TIMING DEVICES

STRUTHERS DUNN, INC., 1319 Cherry St., Phila., Pa.

TRANSFORMERS BY Acme — SEND FOR BULLETIN



- AIR COOLED; standard industrial and P. F. correction.
- MERCURY VAPOR High Intensity Lamp; for industrial and daylight flood lighting.
- FLUORESCENT LAMP BALLASTS
- INSULATION BREAKDOWN TESTERS

THE ACME ELECTRIC & MFG. CO.
43 WATER ST. CUBA, N.Y.
Acme ACME Electric

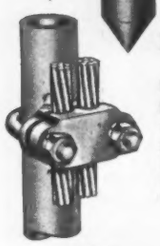
HIGH GRADE HARD PORCELAIN FOR Electrical Specialties
High and Low Voltages

IMPERIAL PORCELAIN WORKS
TRENTON, NEW JERSEY

The MOST COMPLETE
LINE OF
Grounding Connectors

These pictures can only give you an idea of the variety, because —
Penn-Union makes ALL good types.
A complete line of clamps, studs and connectors for all applications. For all combinations of pipe, rod, flat bar, cable, braid, tubing.

Every one a **DEPENDABLE** unit of protection for personnel and equipment — of ample capacity, high mechanical strength, and resistant to corrosion.



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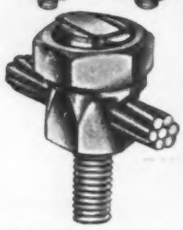

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Sales Opportunities

VAN BUREN, ARK. — Oklahoma Gas & Electric Co., Arkansas Division, Fort Smith, Ark., plans new 36,400-volt transmission line from Fort Smith to Van Buren, about 10 miles. Permission has been secured and work will be placed under way soon. Power substation facilities will be increased at last noted place.

KANSAS CITY, KAN.—Fruehauf Trailer Co., 10940 Harper Avenue, Detroit, Mich., manufacturer of motor trailers, semi-trailers, parts, etc., plans installation of motors and controls, transformers and accessories, switchgear, industrial lighting system, duct lines, conveyors, electric hoists and other equipment in new branch plant in Fairfax industrial district, Kansas City, where large tract of land has been selected. It will consist of a main one-story unit, about 150x1,500 ft., and several smaller structures, and will be used for production of semi-trailers and kindred equipment for government. Work will be placed under way at once. Cost estimated over $1,500,000. Charles E. Keyser, Merriam Building, Kansas City, is architect. Company is now operating a branch plant at Funston and Chrysler Roads, same city.

VINTON, IOWA—Light and Water Department receives bids until November 4 for extensions and improvements in municipal power station and electrical distribution system. Stanley Engineering Co., Muscatine, Iowa, is consulting engineer.

TULSA, OKLA.—Public Service Co. of Oklahoma, Tulsa, will furnish power supply for new aircraft plant now in course of construction near city, to be used for assembling operations; it will be owned by government and operated by Douglas Aircraft Co., Inc., Santa Monica, Calif. Transmission line will be built to plant site, where large power substation will be located. Work is scheduled to be carried out at once.

DENVER, COLO.—Bureau of Reclamation, Custom House, Denver, receives bids until November 3 for one or two vertical-shaft, 115,000-hp. hydraulic turbines, and for one or two oil-pressure, actuator-type governors for regulating speed of turbine noted, for Unit N-7, or Units N-7 and N-8, Boulder power plant, Boulder Canyon project, Arizona - California - Nevada (Specifications 1001). Equipment will be installed by government.

MASSILLON, OHIO—Ohio Public Service Co., Cleveland, Ohio, plans two new power substations at Massillon, in connection with line extensions and changes in city and vicinity for service for government projects.

BELOIT, WIS.—Wisconsin Power & Light Co., Madison, Wis., plans addition to steam-electric generating station on Pleasant Street, Beloit, with installation of turbine-generator unit, high-pressure boilers and auxiliary equipment for increased capacity. Also will build one or more new power substations in city and expand present substation units, with extensions in transmission and distributing lines, service facilities, etc. Entire program will be carried out over a period of 36 months, and is estimated to cost close to $4,000,000. It is proposed to begin work soon. Sargent & Lundy, Inc., 140 South Dearborn Street, Chicago, Ill., is consulting engineer.

AUSTIN, TEX. — International Agricultural Corp., 61 Broadway, New York, N. Y., affiliated with Union Potash & Chemical Co., same address, proposes to build new metallic magnesium plant for production for government on site near Austin, instead of in vicinity of Carlsbad, N. M., and is selecting tract of land for project, on which work is scheduled to begin soon. Mill will be electrically-operated, as previously stated, with installation of motor-generator sets, motors and controls, regulators, switchgear, electric hoists, conveyors, interior and exterior lighting systems, duct lines and other equipment. Power supply will be secured from hydroelectric power development of Lower Colorado River Authority, Austin, with construction of transmission lines to plant site, where large power substation will be located. Entire project is estimated to cost about $12,300,000, including development of raw material properties, estimated to cost approximately $1,700,000 of gross amount for ore-extraction mill and other structures, likewise to be electrically-operated. Fund in amount noted will be provided by Defense Plant Corporation, Washington, D. C., a Federal agency, for project.

PORTLAND, ORE.—United States Engineer Office, Pittock Block, Portland, receives bids until October 28 for designing, manufacturing and testing 15-kv. metal-enclosed buses for Units Nos. 7 to 10, inclusive, and for transfer bus extension to Bonneville power station, Bonneville dam (Circular 698-4202).

VALDOSTA, GA.—Georgia Power & Light Co., Valdosta, plans extensions in transmission lines, including new line for connection with high-tension system of Georgia Power Co. for interchange of power.

WATERLOO, WIS.—Water and Light Commission has plans maturing for expansion and improvements in municipal steam-electric generating station, to include installation of a new 750-kw. turbine-generator unit and accessories, 330-hp. boiler and auxiliary equipment. Cost estimated close to $100,000. Application recently was made for permission and work will begin as soon as this is granted. Commercial Testing & Engineering Co., 307 North Michigan Avenue, Chicago, Ill., is consulting engineer.

ERIE, PA.—Erie Lighting Co. is considering plans for expansion in steam-electric power station on Front Street, with installation of new turbine-generating unit, high-pressure boilers and auxiliary equipment. Also will enlarge switchyard and make extensions in transmission lines. Project will be carried out over a period of months and is reported to cost in excess of $2,500,000.

KREMMLING, COLO.—Bureau of Reclamation, Custom House, Denver, Colo., receives bids until November 4 for three 8,000-kva., 60-cycle, single-phase, oil-immersed, self-cooled, outdoor-type transformers, 39,840/69,000 Y to 115 delta-volt, with automatic tap-changing underload equipment; seven, 4,000-kva. similar type transformers, 6,900 delta to 39,840/69,000 Y-volt; four 200-kva. similar type transformers, 66,000/2300-volt; five 69,000-volt, 600-amp., three-pole, single-throw, outdoor-type oil circuit breakers; three 7,500-volt, 400-amp., similar type oil circuit breakers; five 69,000-volt, 600-amp., three-pole, single-throw, manually-gang-operated, horizontal upright mounting, outdoor type, disconnecting switches; 33 69,000-volt, 600-amp., single-pole, single-throw, hook stick-operated, outdoor-type disconnecting switches; nine 7,500-volt, 400-amp., similar type switches; also, current transformers, coupling capacitors and accessory equipment for Green Mountain power plant, Colorado-Big Thompson project, Colo. (Specifications 1002). All equipment will be installed by government.

New Funds Allotted for Rural Projects

Rural Electrification Administration recently announced allotments to enlarge a cooperative power distribution system in Pennsylvania and to construct a cooperative power generation and transmission system in south Alabama and north Florida.

The Pennsylvania allotment is to the Adams Electric Cooperative of Gettysburg, Calvin A. Cluck, supt., $487,000 to construct 396 additional miles of line to serve 1,300 members in York, Franklin and Cumberland counties, construct a new office building and complete construction already started.

The other allotment is $2,500,000 to Alabama Electric Cooperative of Montgomery, Ala., M. A. McWilliams, president, an organization of Alabama and Florida cooperatives, to build a 12,500-kw. generating plant and 381 miles of transmission line. This plant is necessary because the member cooperatives are faced with a power shortage. They cannot get additional power from present suppliers to meet normal expansion and are forced to reduce present use by 30 percent.

Among allotments announced early in October, bringing total REA loans to $396,843,821, were the following:

ALABAMA—North Alabama Electric Cooperative, Stevenson, J. E. Lillard, supt., $38,000 to complete a section of the system.

ARKANSAS—Carroll Electric Cooperative Corp., Berryville, Paul F. Arnold, supt., $61,000 to complete a section of the system.

COLORADO—Gunnison County Electric Assn., Inc., Crested Butte, V. A. Morgan, supt., $120,000 for construction and installation of a hydro-electric generating plant.

IDAHO—Northern Idaho Rural Electrical Rehabilitation Assn., Inc., Sandpoint, Clen A. Smothers, supt., $195,000 for completion of a generating plant.

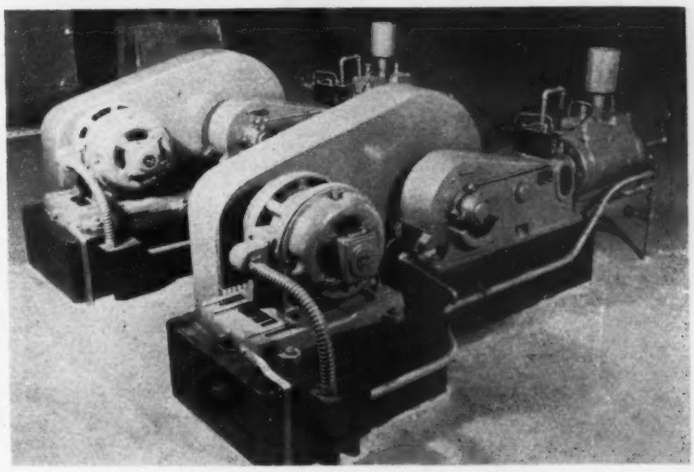
INDIANA—Parke County REMC, Rockville, Reuben Dooley, manager, $45,000 to build 22 miles of line, 64 members in Parke, Putnam, Fountain, Vigo and Montgomery counties, and to complete a section of the system.

KENTUCKY—South Kentucky Rural Electric Cooperative Corp., Somerset, F. D. Gregory, supt., $223,000, partial allotment, total of which will build and acquire 342 miles of line, 1,351 members in Pulaski, Casey, Clinton, Lincoln, Wayne, McCreary and Russell counties.

MICHIGAN—Oceana Electric Cooperative, Hart, Loyal Churchill, supt., $55,000 to build 33 miles of line, 110 members in Oceana, Newaygo, Mason and Muskegon counties and for tie-line and rephasing and member service connections.

MINNESOTA—North Itasca Electric Cooperative, Inc., Bigfork, Martin Nesseth, president, $23,000 to build 41 miles of line, 115 members in Itasca and Koochiching counties.

NEW JERSEY—Tri-County Rural Electric Co., Inc., Freehold, William Jackman, supt., $25,000 to build 15 miles of line, 72



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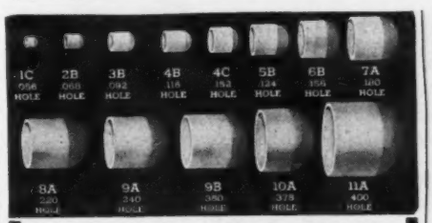

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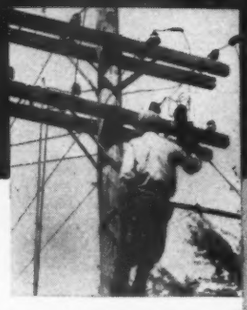

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members in Burlington, Ocean and Monmouth counties.

NORTH CAROLINA — Roanoke Electric Membership Corp., Rich Square, L. W. Anderson, manager, $25,000 to complete a section of the system.

OHIO—Lorain-Medina Rural Electric Cooperative, Inc., Wellington, Harry Bovard, supt., $27,500 to build 8 miles of line, 20 members in Ashland County and to complete a section of the system.

TENNESSEE—Mountain Electric Cooperative, Mountain City, C. C. Blevins, president, $218,000 to build 130 miles of line, 804 members in Johnson and Carter counties and to complete a section of system.

TEXAS — Farmers' Electric Generating Cooperative, Inc., Gilmer, $1,450,000 to complete generating plant and transmission lines.

VERMONT—Halifax Electric Cooperative, Inc., West Halifax, Walter N. Cook, supt., $52,000 to build 25 miles of line, 65 members in Windham County, Vt., and Franklin County, Mass., and to complete first section of system.

Construction contracts recently approved include the following:

ALABAMA—North Alabama Electric Cooperative, Stevenson, J. E. Lillard, supt., and Gordon Persons and Co., Montgomery, Ala., engineer, contract to Roy Richards, Carrollton, Ga., 103.6 miles of line, 291 members; bid, $114,526.

ARKANSAS—South Central Arkansas Electric Cooperative, Inc., Arkadelphia, Midwestern Engineering & Construction Co., Tulsa, Okla., engineer, contract to Walco Engineering & Construction Co., Tulsa, Okla., 104 miles of line, 219 members; bid. $79,126.

ILLINOIS—Egyptian Electric Cooperative Assn., Inc., Steeleville, Theodore F. Fieker, supt., and Stanley Engineering Co., Muscatine, Iowa, engineer, contract to Donovan Contracting Co., St. Paul, Minn., 369.2 miles of line, 661 members; bid, $297,089. Southern Illinois Electric Cooperative, Dongola, George W. Endicott, Manager, and Stanley Engineering Co., Muscatine, Iowa, engineer, contract to Donovan Contracting Co., St. Paul, Minn., 49.1 miles, 100 members; bid, $37,370.

MICHIGAN—Tri-County Electric Cooperative, Portland, Dolph H. Wolf, supt., and J. and G. Daverman, Grand Rapids, Mich., engineer, contract to Fred R. Harris, Jackson, Mich., 48 miles of line, 134 members; bid, $34,651.

MISSISSIPPI — Southern Pine Electric Power Assn., Taylorsville, H. L. Pickering, supt., and Bowman and Bowman, Greenwood, Miss., engineer, contract to Delta Construction Co., Clarksdale, Miss., 433 miles of line, 1,674 members; bid, $276,801.

OHIO—Logan County Cooperative P. and L. Assn., Inc., Bellefontaine, Putnam and Woolpert, Dayton, Ohio, engineer, contract to Kelso-Wagner Co., Dayton, Ohio. 82 miles of line, 225 members; bid, $62,546.

SOUTH DAKOTA—West River Electric Assn., Inc., Wall, Neil Rounds, supt., and Walter Walkling, Rapid City, S. D., engineer, contract to Langford Electric Co., Inc., Minneapolis, Minn., 171.9 miles of line, 315 members; bid, $114,004.

TEXAS—Johnson County Electric Cooperative Assn., Cleburne, T. W. Bailey, supt., and Texas Engineering Co., Austin, Texas, engineer, contract to McClure Electric Co., Dallas, Texas, 129 miles of line, 211 members; bid, $76,735. Bandera Electric Cooperative, Bandera, W. W. Cardwell, supt., and Texas Engineering Co., Austin, Texas, engineer, contract to Zanes Freight Agency, Dallas, Texas, 300 miles of line, 346 mem-

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bers; bid, $169,294. Fort Belknap Electric Cooperative, Inc., Olney, Thomas H. Wilkinson, supt., and Joe E. Ward, Wichita Falls, Texas, engineer, contract to Reinhart and Donovan Co., Oklahoma City, Okla., 205.47 miles of line, 292 members; bid, $103,123.

VIRGINIA—Prince William Electric Cooperative, Manassas, John Y. Roseberry, supt., and Welles Engineering Co., Front Royal, Va., engineer, contract to G. E. Barrow, Blackstone, Va., 207.5 miles of line, 470 members; bid, $154,187.

BOOK REVIEWS

Standard Handbook for Electrical Engineers

Seventh Edition. Archer E. Knowlton, editor-in-chief; R. M. Shoop, assistant editor. Published by McGraw-Hill Book Co., New York City. 2,303 pages, illustrated. Price, $8.

Although in this new edition the classic electrical engineering encyclopedia has been entirely rewritten and is of standard book size, larger than the inaccurately termed "pocket" dimensions of previous editions, it follows the pattern set in the past closely enough so that users will not find a wholly unfamiliar manual in their hands. In its 26 sections are combined the works of 102 authors, most of them new to the book and each an authority in his special field, the whole correlated and organized in the intention to present in compact form what the editor-in-chief terms primarily "an encyclopedia of applicable information and secondarily an epitome of the academics of electrical phenomena." Inspection of the book appears to bear out this editorial intention, for, while the fundamentals of electrical engineering are by no means neglected, conspicuously to be noted are today's conditions, as reflected in new problems of application and operation, in later developments of equipments and devices and in the past ten years of progress in the electrical arts. Recognition is given to such typical modern developments as air conditioning, electricity in aviation and in the petroleum industry, lightning technology, high-voltage generators and cyclotrons. Outstanding among the many thoroughly revised sections is one of particular value, that of "Codes and Standard Practices," which now contains about 1,000 listings of published specifications and prescribed practices and the sources from which they may be obtained.

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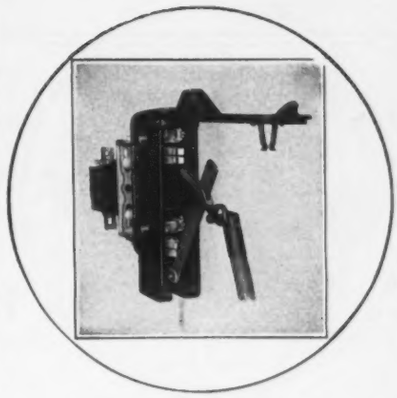
Surge Phenomena

Seven Years' Research for the Central Electricity Board. Published by The British Electrical and Allied Industries Research Assn. London, England. 426 pp., illustrated. Price, £2 10s.

Superb companion to the A.I.E.E. Lightning Reference Book (published in 1937) is the newly available "Surge Phenomena," constituting a record of the 1933–40 analyses and researches for the Central Electricity Board. It digests and correlates world-wide experience and takes up the component parts of the problem in logical, evolutionary order and thus affords a more connected approach than the collection of papers which comprise the American volume. Each aspect is converged toward conclusions, most of which confirm our deductions, and toward recommendations



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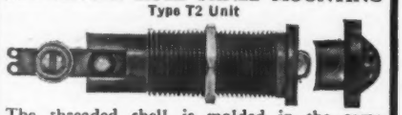

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for further work. Field change measurements and extended simultaneous field plots are seen as necessary supplements to camera records. Klydonographs are accepted for 3-15 kv. Surge voltages on lines do not necessarily attend nearby thunderstorms. Tower leg links would be improved by use of more than a single magnetic material, with two links of different range an alternative. Negative cloud polarities predominate in Nigeria. No attempt was made to duplicate American efforts to establish a universal formula for attenuation or distortion of propagated surges. Tests on 33- and 132-kv. lines comprise two of the 25 chapters. Coupling coefficients are found only slightly affected by a second overhead ground wire. Footing surge impedances can be lower than measured d.c. values. There are three comprehensive chapters on surge voltage distribution in transformers and three more on cables and insulators. Final chapters deal with the protection problem. Caution is advised in drawing too much guidance from model tests. Surge absorbers are found to have merit in modifying steepness and tail slope of surges. Rod gaps are consistent, expulsion gaps less so. The final chapter epitomizes the results in the form of recommendations for system protection, tabulating the accepted characteristics of protective devices most usefully.

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Mechanical Engineers' Handbook—Fourth Edition

Edited by L. S. Marks. McGraw-Hill Book Co., New York. 2274 pages, illustrated. Price, $7.

Engineering information clarifies, changes emphasis and expands in new directions to a great degree in eleven years. That has manifestly warranted a new (fourth) edition of Marks,' one which is found to give stress and new space to new data and practices at the expense of techniques which are being superseded. Electrical engineers will find the book dovetails nicely with their favorite electrical handbook for those jobs which straddle the two fields of engineering. There is a condensed electrical section, but it is more likely they will have recourse to the rewritten sections on power plant components, refrigeration, thermodynamics, heat transmission and hydraulics, as well as to certain of the freshly introduced treatments of plastic behavior of materials, creep, stress concentration, wind pressure on structure, automatic control of processes and powder metallurgy.

Tables of data from experiment and from experience are profuse. The many tabulations of performance characteristics of conventional assemblies are infinitely more useful for reference than didactic text. Here the editor has been a master at terse condensation so as to make room for ever new material. But where is the engineer who would not prefer more useful facts to many less useful words?

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Books Received

Lessons in Arc Welding. Lincoln Electric Co., Cleveland, Ohio. 176 pages, illustrated. Price, 50 cents in U.S.A. Sixty practical graded lessons (questions and answers included) to help make better welds and better welders quickly.

Wage and Hour Manual, 1941 Edition. Bureau of National Affairs, Inc., 2201 M Street, N.W., Washington, D. C. 1120 pages. Price, $5.

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LETTER TO THE EDITOR

Depreciation Rate of Fluorescent Illustrations

To the Editor of ELECTRICAL WORLD:

Your issue of September 20 contains an article by C. C. Mills entitled "Relative Costs of Industrial Light Sources," which particularly compares the operating expense of incandescent and fluorescent units. Sufficient details are not given in the article to permit of its thorough analysis by the reader.

However, one premise is made which, from the standpoint of sound economics, should not go unchallenged. I refer to the fact that amortization on the incandescent units is taken at 10 percent and on fluorescent, because of the rapid advances in the art, at 20 percent, making the total fixed charges against the latter 30 percent. I consider this 30 percent figure much too high for industrial installations, but whether it is or not, there is, in my opinion, no justification for a lower rate of depreciation on incandescent fixtures than on fluorescent. If fluorescent equipment is being improved so rapidly that in a few years one can afford to throw away expensive fluorescent fixtures already purchased, how much more will it be worth while at that time to replace an incandescent lighting system which is not in too strong a competitive position in the present day! If any differential in depreciation rates can be justified, it certainly should be against, rather than in favor of, the less rapidly progressing illuminant.

WARD HARRISON,
Director of Engineering
General Electric Lamp Dept.
Cleveland, Ohio

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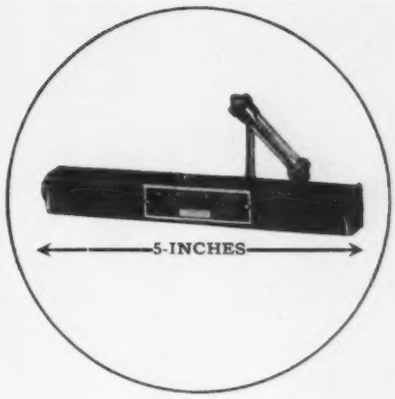
Need St. Lawrence Power for Defense, Says FPC

In a recent letter addressed to Representative Joseph J. Mansfield, chairman of the rivers and harbors committee, Leland Olds, chairman of the Federal Power Commission, stated that it is fallacious to consider the St. Lawrence River power project and coal-burning plants as rivals. "Both are needed," the letter said. The letter concludes with the statement that "it would be a grave error in military planning to delay immediate construction of the St. Lawrence River power project."

Up-state New York is now short of power, the letter says, and even with the



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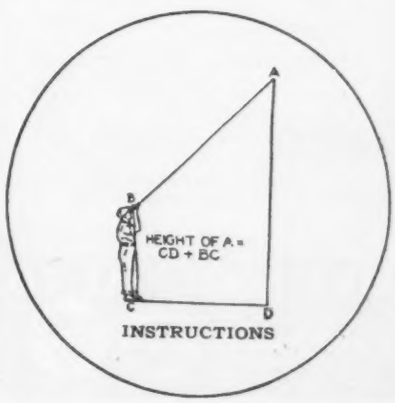

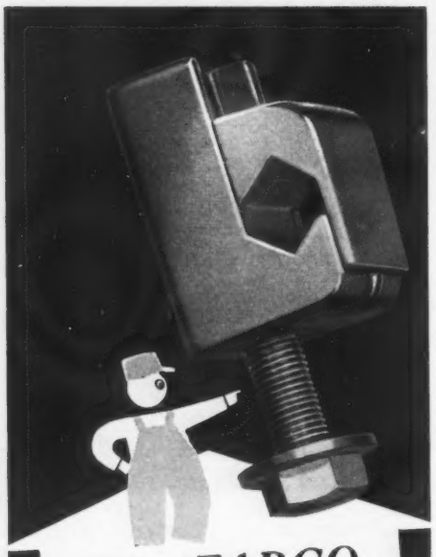

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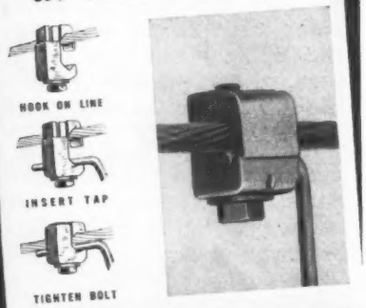

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completion of the St. Lawrence project in 1945, that area will be 394,000 kw. short of the capacity estimated to be required for the expansion of essential defense production unless further additions to generating capacity are planned.

•

1,088 Kw.-Hr. Available for Each Person in U. S.

Each of the 131,669,275 people in the United States had 1,088 kw.-hr. available for his use in 1940, according to energy production figures reported by the Federal Power Commission. Actual use by each of the 30,191,000 light and power customers in the U. S. was about 3,998 kw.-hr., according to the Edison Electric Institute.

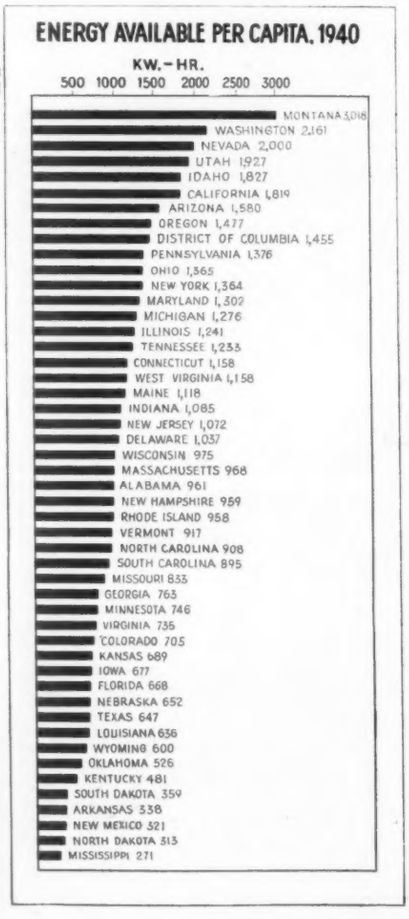
Five states, with 34.2 percent of the country's total population, accounted for 44.5 percent of the total available energy last year. New York led, with 18,375,044,000 kw.-hr., or 12.8 percent of the total, and 13,479,142 people, a little more than 10 percent of the total. Montana was first in energy available per capita, with 3,018 kw.-hr. for each of its 559,456 inhabitants. Accompanying graphs show energy available by states and per capita for 1940.

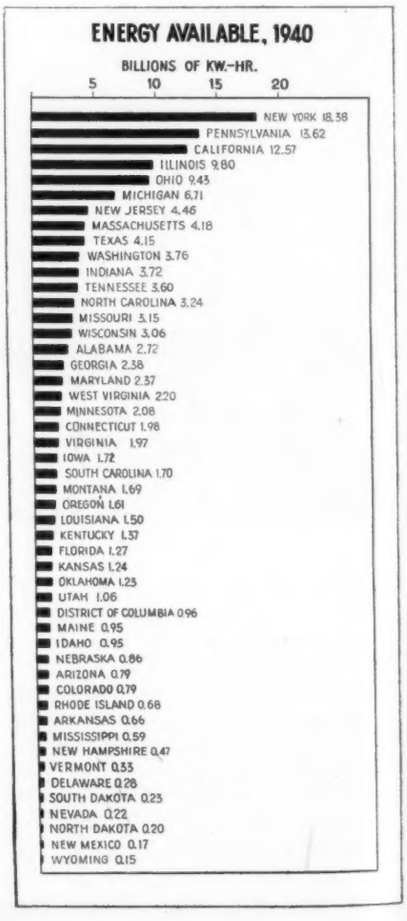
Protests Granting of Metals to REA

National Economy League has cited the recent allocation to the Rural Electrification Administration of 4,500 short tons of copper per month and lesser quantities of steel, zinc and aluminum as an illustration of what it called the failure of the Federal Government to reduce its non-defense construction activities in proportion to the requirements demanded by the extensive defense program.

The league said: "The same materials allocated to industries which have long used them for essential parts would probably forestall a significant amount of 'priority unemployment.' The closing of a factory on which workers depend for employment in established occupations and localities is a much more serious dislocation than the postponement of those rural electrification projects which have been merely started or proposed."

The prospective reduction in the number of electrical appliances sold would seem to interfere with profitable operation of REA lines started now, the league added. The agency's increasing expenses were said to be "a direct public subsidy to the benefited groups."





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Recent Rate Changes

CENTRAL NEW YORK POWER CORP. has been granted permission by the state Public Service Commission to put into effect reduced rates for residential electric service in the cities of Fulton and Oswego which will save domestic consumers approximately $30,600 annually. About 8,700 customers in these two cities will benefit from the reduction. The new rates became effective October 15. The new residential rates will be as follows: minimum charge is reduced from 95 to 90 cents per meter per month and the allowance of current in the initial charge is increased from 12 to 15 kw.-hr. per month; thus the consumer is assured of more current for less money. The next 45 kw.-hr., that is, between 15 and 60 kw.-hr. inclusive, will be 4.4 cents per kilowatt-hour, as against 4.8 per kilowatt-hour under the existing rate. Beyond the 60 kw.-hr. block the rate remains the same as under the present schedule at 2.5 cents per kilowatt-hour. The corporation has also filed revised rate schedules for commercial and industrial service for its entire territory. Under this revision commercial and industrial customers in the Fulton-Oswego district would receive reductions of approximately $44,000 per annum, while the gross reduction for the entire territory would be about $596,000, affecting approximately 16,000 customers.

ARKANSAS POWER & LIGHT CO. has been authorized by the state Utilities Commission to increase rates paid by 450 commercial customers. The increase amounts to $97,000. These customers have been enjoying a favored rate.

ILLINOIS COMMERCE COMMISSION has announced that rate changes effective during the month of September resulted in an estimated decrease of $31,069 in annual operating revenues. Electric rate cuts totaled $31,206, but a slight increase in the rates of a telephone company brought the total down to $31,069.

•

Columbia Electric Plans Expansion of Plant

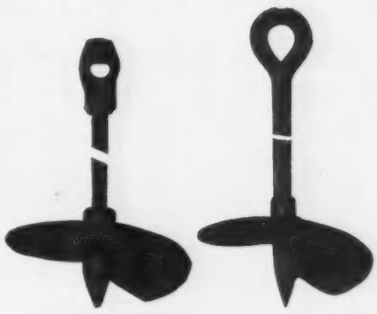
Columbia Electric Manufacturing Co., Cleveland, Ohio, has plans in progress for a one-story addition at St. Clair Avenue and East 45th St., totaling about 50,000 sq.ft. of floor space, to provide for large increase in capacity. General erection contract will be awarded soon.

Company also will remodel and improve an existing three-story building of about 25,000 sq.ft. of floor space, which it will also use for expansion. Contract for the latter work has been let to Dean W. Rankin, Cleveland.

•

Stockholders Increase

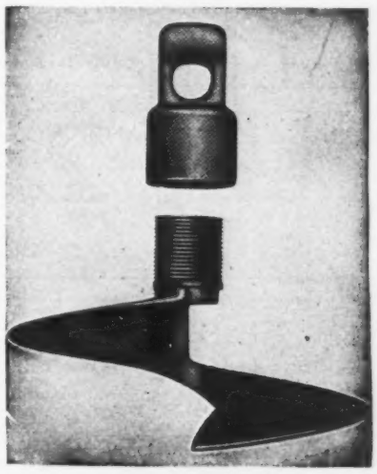
General Electric stockholders on September 19 totalled 218,152, an increase of 6,541 over a year ago. The present number to whom the October 25 dividend will be paid is an increase of 812 over the last record date, June 27, 1941.



Matthews Scrulix Anchors

shown above were first put on the market in 1900. The one on the left is put down with a wrench. The one on the right is screwed down by putting a bar through the eye. The one shown at the bottom of this column is for use in swampy places and is put down with standard 1½ or 2-inch pipe.

Over 3,000,000 Matthews Scrulix Anchors have been sold and thousands of them are purchased every year. This type of anchor is ideal for use in dry loose sand, loamy ground; under shallow stands of water; on beaches and in swamps. They are made in sizes ranging from 4 inches in diameter to 12 inches. You will find that the 4-inch size will help reduce costs on those cheap rural lines. They will save you money over any anchor that requires the digging and filling of holes. Write for Bulletin 804.



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Electric Service to Third of U. S. Farms

One third of the nation's farms had electric service on April 1, 1940, when the last decennial census was taken, completed tabulations of that survey show. Of a national total of 6,096,789 farms, the census discloses that 2,032,372 had electric service. An additional 179,066 farms reported use of a home electric plant.

Another tabulation made as a result of the census shows that in addition to farms receiving service, roughly 750,000 others were located within a quarter of a mile of a distribution line but did not have service. These figures become more impressive in view of the fact that of the total farms, the census report shows about 2,000,000 have dwellings valued at less than $500.

Superimposing the nearest comparable Rural Electrification Administration report onto the census survey discloses that REA co-ops, in the spring of last year, were furnishing service to 27 percent of the farms having electric service. Where the Census Bureau shows 2,032,372 farms with electric service on April 1, 1940, REA reported serving 549,604 farms on June 30 of the same year.

First rank among the states in electrified farms is New Jersey, with 84 percent of its 25,835 farms having service. Following, in order, are Massachusetts, 26,848 farms with service, or 83.5 per cent; Rhode Island, 2,511, 83.3; California, 110,014, 82.9; Connecticut, 17,494, 82.7; Washington, 60,082, 73.6; Michigan, 133,095, 71; New York, 106,804, 69.7; Utah, 17,714, 69.7; New Hampshire, 11,184, 67.6; Oregon, 38,101, 61.5; Ohio, 143,436, 61.4; Idaho, 26,384, 60.4; Pennsylvania, 98,937, 58.5; Vermont, 12,783, 54.6; Maine, 21,124, 54.2; Indiana, 95,575, 51.8; Wisconsin, 95,158, 51; Nevada, 1,812, 50.7; Maryland, 18,351, 43.6.

Comparable REA figures of farms served as of June, 1940, for the same top 20 states are: New Jersey, 1,041; Massachusetts, none; Rhode Island, none; California, 3,255; Connecticut, none; Washington, 4,364; Michigan, 20,887; New York, 3,876; Utah, 1,035; New Hampshire, 194; Oregon, 1,509; Ohio, 36,026; Idaho, 3,671; Pennsylvania, 15,143; Vermont, 443; Maine, 177; Indiana, 45,071; Wisconsin, 20,866; Nevada, 417, and Maryland, 1,376.

•

Issues New Publication

Ajax Metal Co., Philadelphia. Pa., has announced the issuance of a new magazine for metals executives. The

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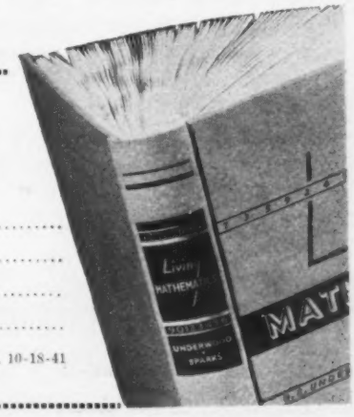

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new publication, known as *Ajax Metelectric Progress,* will appear bimonthly, following its first issue on October 1. The publication will be edited by Howard Linn Edsall, formerly of the staff of the Philadelphia *Public Ledger.*

•

Wisconsin Units Will Interconnect Lines

Wisconsin Electric Power Co., Wisconsin Gas & Electric Co., and Wisconsin Public Service Corp. have announced that they had arrived at an agreement, subject to the approval of the Public Service Commission of Wisconsin, which will result in the interconnection of the Wisconsin Electric Power Co. and its subsidiary Wisconsin Gas & Electric Co. 132,000-volt system in the Elkhart Lake, Wisconsin, area with the 66,000-volt system of Wisconsin Public Service Corp., which presently terminates at New Holstein, Wis.

It was stated that this connection will be of substantial benefit in assuring continuity of service in New Holstein and Elkhart Lake and the territory contiguous thereto, as well as generally beneficial to the two power systems.

It is expected that the connection between New Holstein and Elkhart Lake will be made early in the spring of 1942 if the necessary equipment and materials can be secured by that time.

•

Order New Equipment for Shasta Plant

Additional power equipment for the Shasta Dam power plant on the Central Valley project in California has been ordered by Secretary of the Interior Harold L. Ickes.

Contracts totaling $1,309,155 were awarded to three companies for furnishing sixteen power transformers, five bus structures and five transformer-neutral bus structures for the five big 75,000-kw. generating units to be installed in the Shasta power plant.

Westinghouse Electric & Manufacturing Co. on its bid price of $607,865 will supply six 25,000-kva., oil-immersed transformers; five 15,000-volt, 3,200-amp. bus structures with potential transformers, current transformers, ground switches and generator lightning arresters and capacitors, and five transformer-neutral bus structures.

Allis-Chalmers Manufacturing Co. will furnish four 21,000-kva., oil-immersed transformers for a price of $279,700. General Electric Co. of Schenectady will furnish six 25,000-kva., oil-immersed transformers on a bid of $421,590.

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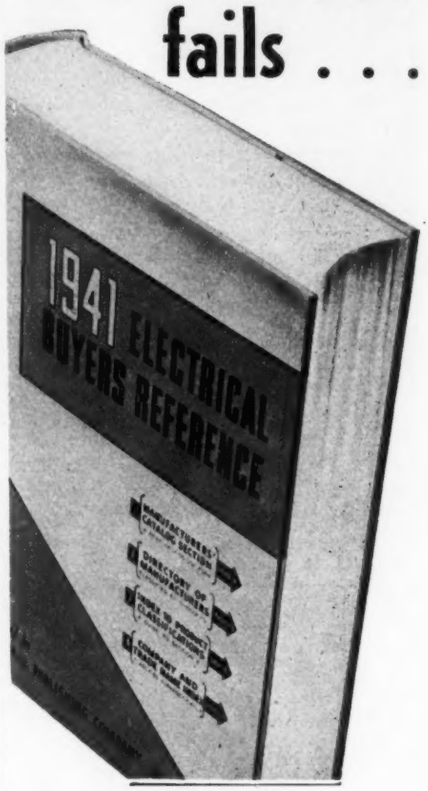

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Reclamation Bureau to Triple Capacity

A detailed schedule of the Bureau of Reclamation's plans to triple its generating capacity in the next 3½ years shows a planned capacity of 2,621,062 kw. by December 31, 1944, compared to 953,962 kw. at present.

Reflected in the new government power program are all increases voted by Congress so far this year, such as authorization to start work on the Bullshead and Keswick dams, and increases in the pace of work at other projects, particularly at Shasta and Grand Coulee.

In announcing its present schedule, the bureau added that study is being given continuously to means "of adapting the program to changing requirements." It is known, for instance, that Secretary Ickes would like to get money from Congress permitting him to order additional generators for Grand Coulee quickly. Six units now are on order or appropriated for.

Reclamation's schedule of generating installation follows:

	Kw.	Kw.
Capacity in 28 operating plants, as of May 1, 1941		953,962
Grand Coulee Dam, August, 1941		108,000
Boulder Dam, August		82,500
Grand Coulee, December		108,000
Boulder, December		82,500
Parker Dam, December		30,000
To be added June-December, 1941	411,000	
Total by close of 1941	1,364,962	
Grand Coulee, March 1942		108,000
Boulder, July		82,500
Parker, January		30,000
Parker, February		30,000
To be added during 1942	250,500	
Total by close of 1942	1,615,462	
Grand Coulee, June, 1943		108 000
Parker, July		30,000
Grand Coulee, July		108,000
Green Mountain Dam, July		21,600
Grand Coulee, August		108,000
Keswick Dam, October		75,000
To be added during 1943	450,600	
Total by close of 1943	2,066,062	
Shasta Dam, January, 1944		375,000
Davis Dam (Bullshead), June		180,000
To be added during 1944	555,000	
Total by close of 1944		2,621,062

New Hampshire Hydro Development Urged

Chairman Leland Olds of the Federal Power Commission has urged the New Hampshire Water Resources Board to approve a plan for the hydroelectric and flood-control development of the Contoocook River in New Hampshire which would provide electric power for the national defense program as soon as possible.

During meetings of the board at Peterborough, Henniker and Concord, N. H., to consider alternate plans submitted by the Federal Power Commission and the Corps of Engineers, U. S. Army, for the development of the river, Chairman Olds stressed the defense

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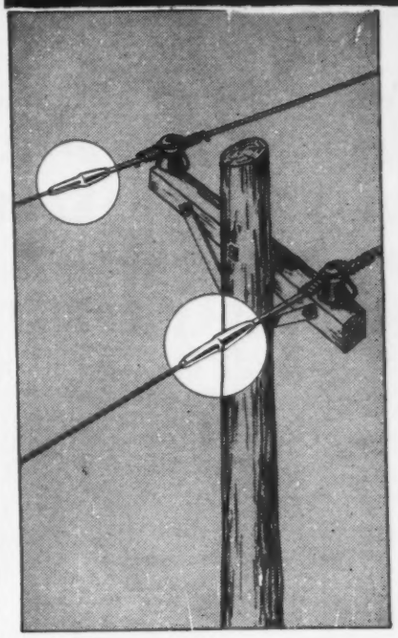

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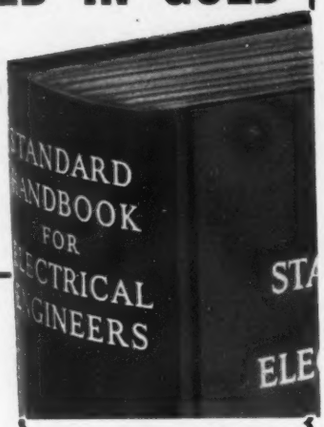

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emergency need for electric power in the New England area.

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•

Spends $10,000,000 on New Facilities

Montreal Light Heat & Power Consolidated in 1940 and 1941 (the first two years of the war) is spending more than $10,000,000 in providing new power production and distribution facilities, John S. Norris, president, reveals in a letter to shareholders.

"This has been, and is, making possible," said Mr. Norris, "the construction of scores of war plants in Quebec province. The company is spending this money out of its own resources and it is consequently unnecessary for the people of Canada to provide, through their government, any part of this cost at a time when government war expenditures already are so tremendous.

"On the contrary (in addition to financing the development of new power facilities at this huge expenditure and out of their own resources) your company and the other private power companies in Quebec province are contributing in income taxes to the Dominion Government a large part of the amount required for carrying on this very expensive war."

"The private power companies in this province, placing ahead of everything else their determination to do all they can to help win the war, have coordinated all available power resources and facilities so that their efforts and contribution can be most effective," the letter stated.

•

Bomber Plant to Install York Cooling System

York Ice Machinery Corp. has obtained from the Manhattan Construction Co. of Muskogee, Okla., and the Long Construction Co. of Tulsa a contract for the mechanical refrigeration system to be used in air conditioning the mammoth, windowless Douglas bomber assembly plant now being built at Tulsa. The cooling systems will have a capacity of 7,000 ice-tons daily.

Announcement has recently been made by the corporation that it will

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REA Presses for an "In" on Defense

[*Continued from page* 107]

poultry products, where electricity can help Mother Nature. Dairy and poultry products are "defense foods."

REA has had no copper allotted to it for line construction since August. In that month it was allotted the full 4,500 tons which the old defense agency OPACS directed it should have monthly throughout this year to complete projects underway. The August quota is now nearly gone, only scrapings from the bottom of the barrel are still coming through. REA doesn't expect to get any more copper so long as there isn't enough even to fill all the A-10 or higher rated orders, which has been the case since September.

Thus REA's activities are "forced" into the field of industrial development in rural areas. This is the direction in which the proponents of the rural co-operative movement want REA to go anyway, the direction in which it started somewhat haltingly before the defense program provided an impetus upon which REA now seeks to capitalize fully.

•

Hydro Opens New Transformer Unit

Ontario Hydro-Electric Power Commission recently opened without any of the peacetime formalities the first unit of the commission's new transformer station in Burlington. This station, which is supplied with power from Beauharnois, is at present served by two lines from Leaside and will form an increasingly important tie between eastern generating sources and the commission's 110,000-volt network.

Although the present capacity of the Burlington station is limited to one transformer bank of 75,000 kva., it is expected that a second bank of the same capacity will be placed in service this month and further additions will be made as required. Provision is being made for an ultimate installation of six banks of transformers, having a total capacity of 450,000 kva.; four incoming 220,000-volt lines, two outgoing 220,000-volt lines and twelve outgoing 110,000-volt lines.

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